project record

EVALUATION

# WEATHERMEASURE CORPORATION MODEL WS750 AUTOMATIC WEATHER STATION

ED&T 1904
FIRE WEATHER STATIONS



AUGUST 1974

U.S. Department of Agriculture
Forest Service
Equipment Development Center
Missoula, Montana

PROJECT RECORD

# AN EVALUATION: THE WEATHERMEASURE CORPORATION MODEL WS750 AUTOMATIC WEATHER STATION

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By

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ELECTRONIC ENGINEER

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## INTRODUCTION

Fieldmen have long expressed the need for a portable automatic measuring and continuous recording fire weather station. Fire behavior officers, for example, have a need for this weather information for their calculations of probabilities on wildfires. The need for a fully instrumented portable weather station on wildfires is greatest in remote locations inaccessible by mobile units.

Portable fire-weather stations are also needed for gathering data for use in planning many fire prevention and presuppression activities, particularly prescribed burning operations and other field activities such as aerial spraying projects for insect control.

The task of designing a portable fire weather station was assigned to the Beltsville Electronics Center (BEC). General design and performance requirements provided to the Beltsville Center stated that the station must provide continuous records (up to 8 days) of acceptable accuracy for dry bulb temperature, relative humidity, windspeed and wind direction. They also had a requirement to provide for making manual measurements of precipitation.

Under contract, the Weather Measure Corporation designed and built three prototype continuous recording portable weather stations for the Beltsville Center. When the BEC was closed in 1972 the three stations were assigned to the Missoula Equipment Development Center for evaluation. These units were received by MEDC in July 1972. One unit was retained for controlled tests and the other two assigned to field units for evaluation.

## DESCRIPTION OF THE PORTABLE WEATHER STATION

The Weather Measure Corporation Model WS750 Automatic Weather Station is shown in figure 1. The recorder is shown installed in a portable aluminum weather instrument shelter.

*Figure 1.--Model WS750 automatic weather station installed in portable shelter.*

Precipitation, temperature, wind direction, wind run (speed) and relative humidity are recorded in 2-inch channels on 12-inch wide pressure sensitive chart paper as shown in figure 2. A 15-foot roll of chart paper accepts 8 days of data. The chart speed is controlled by a tuning fork.

Two rechargeable 12 volt sealed lead-dioxide batteries power the station for 15 to 30 days. A special charger, not supplied with the station, is required to recharge the batteries.

Two containers are provided for transporting the station. One is an aluminum case 32"x18"x19", the other is a canvas bag 52"x20"x4". The station weighs 110 pounds when packaged for transport.

The device used to measure each parameter and the records produced are described below:

Precipitation.--Measured by a tipping bucket rain gage and recorded in 0.01 inch steps with 10 steps across the channel.

Temperature.--Measured by a bimetal strip located on the back of the recorder and recorded on a zero to 100 degree Fahrenheit scale.

Wind direction.--Sensed by a lightweight wind vane located on top of a 15-foot collapsible mast and recorded in 8 segments corresponding to North, Northeast, East, etc.

Wind run (speed).--Measured by a 3-cup contact anemometer located on the mast. Each 1/6 mile of air movement produces one step on the 10 step wide channel. The wind speed in miles per hour is equal to the number of steps in a 10 minute interval.

Relative humidity.--Measured by a three bundle human hair sensor located on the back of the recorder and recorded on a zero to 100 percent scale.

A complete description of the station is provided in the manufacturer's operation and service manual, appendix I.

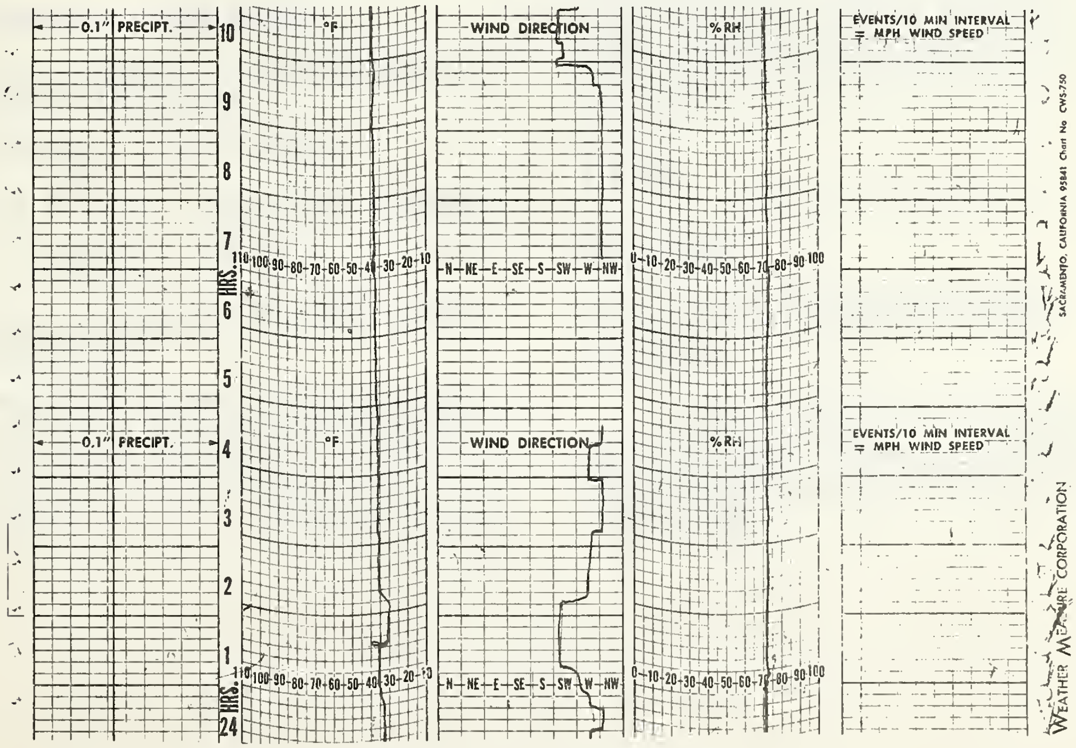


*Figure 2.--Chart paper.*

## TEST PROCEDURE

One portable weather station was set up in a portable aluminum weather instrument shelter near the facilities at Johnson Bell Field, Missoula, Montana, from October 3 to October 20, 1972. The station was located within 50 feet of the Weather Service's instrumentation, except for their rain gage which was located approximately 1/4 mile away on the roof of a building.

The data analyzed was taken between October 5 and October 13. Hourly temperature, dew point, windspeed, and wind direction measurements were read from the Weather Service records and the station parameters were read off the chart for the corresponding times. This data was punched on paper tape and analyzed using a computer. A data listing is contained in the appendix.

During the test period, the Weather Service observations ranged as follows:

Temperature: 25°F to 67°F

Relative humidity (calculated from dew point): 30% to 100%

Windspeed: Zero to 17 mi/h

Wind direction: Through all 8 segments

Precipitation: 0.47 inch

### Method and Accuracy of Weather Service Observations

Temperature and dew point are measured by an aspirated telehygrothermometer 3 feet above the ground. Temperature accuracy is ± 1°F and dew point accuracy is ± 2°F. Converting temperature and dew point to percent relative humidity results in accuracies ranging from ± 4% at 30% relative humidity, ± 8% at 60% relative humidity, to ± 12% for relative humidities greater than 80%.

Windspeed is measured by a 3-cup anemometer 20 feet above ground. The threshold is 3 knots and the accuracy is ± 1/2 knot. The windspeed is averaged for a 1 minute interval.

The wind vane is also 20 feet above ground. Wind direction is averaged for 1 minute and recorded to the nearest 10° with respect to true North. The threshold is 5 knots.

Precipitation is measured by a weighing rain gage with an accuracy of ± 0.005 inch.

### Field Evaluation

Two portable weather stations were evaluated under actual field use. One station was installed on the Gifford Pinchot National Forest in Washington and the other was used on the Powell Ranger District, Clearwater National Forest, Idaho, in prescribed burning operations.

## RESULTS

### Reliability

Three types of malfunctions occurred during the test conducted by MEDC. These were:

1. The chart paper drive sprocket holes ripped out three times because the chart paper is very thin and the force required to advance the paper is fairly large.

2. The wind run recording mechanism jammed because two of the bushings slipped out of place. These bushings were intended to be held in place by being tightly fit. Figure 3 shows the recording mechanism with the bushings located properly.

3. A transistor, which produces pulses to push the humidity and temperature pens against the chart and activate the wind direction recording mechanism, failed. Figure 4 is the schematic of the circuit in which the 2N2160 unijunction transistor is used. $C_t$ is shown on the manufacturer's schematic as 44 microfarads. However, $C_t$ was 66 microfarads in the unit tested.

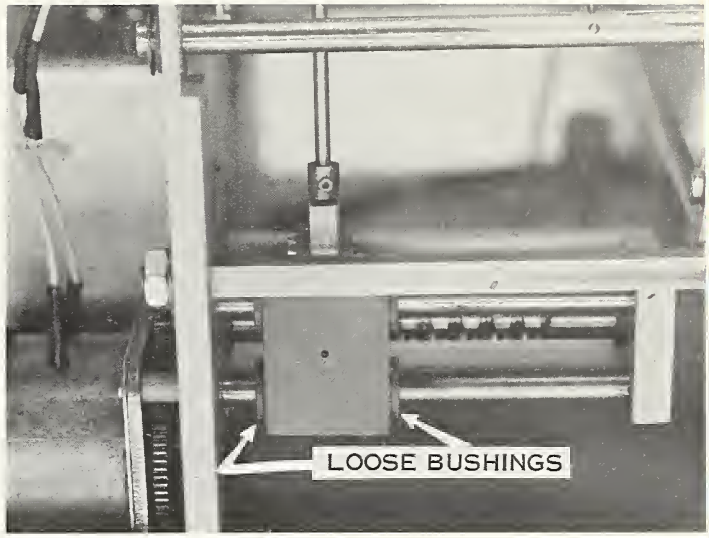


*Figure 3.--Wind run recording mechanism.*

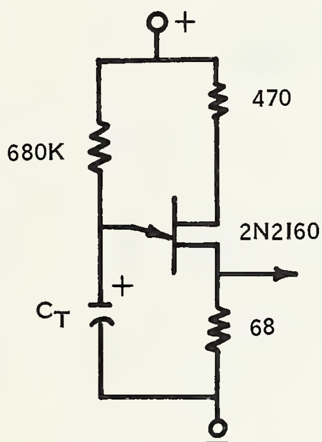


*Figure 4.--Unijunction tranistor pulse circuit.*

According to the "G. E. Transistor Manual", for values of $C_t$ greater than 10 microfarads, a resistor of at least 1 ohm per microfarad should be used in series with $C_t$ to protect the transistor's emitter. Since no resistor was provided, the transistor failure was probably caused by excessive emitter current.

## Accuracy

Temperature.--The temperature data was analyzed to determine how accurately the Weather Service temperature and thus the true temperature can be predicted from a station reading. The total inaccuracy of the station is the result of systematic error and random error. Systematic error can be removed by calibration but random error cannot.

The least-squares fit, average calibration curve is given by:

$$Y = mX + b$$

where:

Y = Weather Service temperature

X = Station temperature

m = Slope of the calibration line

b = Offset of the calibration line

N = Number of data points

$$m = \frac{N\Sigma XY - \Sigma X\Sigma Y}{N\Sigma X^2 - (\Sigma X)^2} \qquad b = \frac{\Sigma Y\Sigma X^2 - \Sigma XY\Sigma X}{N\Sigma X^2 - (\Sigma X)^2}$$

The confidence interval on Y given X is given by:

$$Y_\alpha = (mX + b) \pm t_\alpha S_{Y \cdot X} \sqrt{1 + \frac{1}{N} + \frac{(X - \bar{X})^2}{(N-1)S_X^2}}$$

where:

$$S_{Y \cdot X} = \sqrt{\frac{1}{N-2} (\Sigma Y^2 - b\Sigma Y - m\Sigma XY)}$$

$$\bar{X} = \frac{\Sigma X}{N}$$

$$S_X^2 = \frac{1}{N(N-1)} (N\Sigma X^2 - (\Sigma X)^2) = \text{variance}$$

Since N = 195

$t_{50} = .674$ $\qquad$ $t_{95} = 1.960$

$t_{90} = 1.645$ $\qquad$ $t_{99} = 2.576$

The computer program (XBASIC) used to solve these equations and their solutions are contained in the appendix. The solutions yield the calibration curve defined by Y = .864X+6.44 and the 90% confidence level defined by Y = (.864X+6.44) ± 5. The data and these lines are plotted in figure 5.

If the systematic error was removed through calibration, the station reading would be within ± 5°F of the Weather Service measurement 90% of the time. Since the Weather Service temperature is known to be considerably more accurate (± 1°F), it is reasonable to assume that the station reading will be within ± 5° F of the true temperature.

Note that figure 5 shows considerable hysteresis. This is caused by the slow response time of the bimetal strip used in the station and would probably account for most of the ± 5°F error.

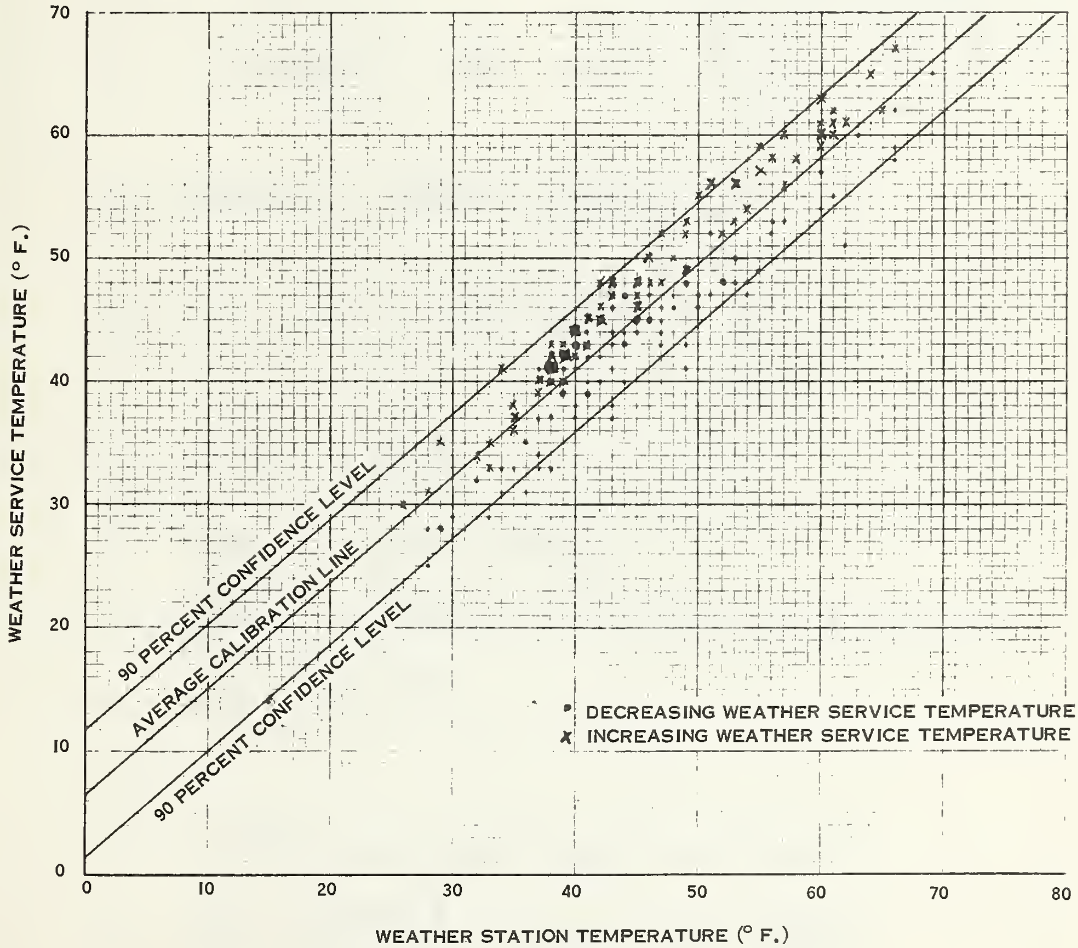


*Figure 5.--Weather Service vs. station temperature.*

Humidity.--Since the Weather Service measures dew point rather than percent relative humidity, it was necessary to convert the Weather Service measurements. Percent relative humidity is defined by:

$$\emptyset = \frac{P_s}{P_d} \times 100$$

where:

$\emptyset$ = Percent relative humidity

$P_s$ = Saturation vapor pressure at dew point temperature

$P_d$ = Saturation vapor pressure at dry bulb temperature

These saturation vapor pressures may be found by solving the following equations at the appropriate temperature.

The saturation vapor pressure for water vapor over water is given by:

$$P_W = 29.921\text{x}10\ (P_1 + P_2 + P_3)$$

where:

$P_W$ = saturation vapor pressure of water vapor over water.

$$P_1 = -7.90298\ \frac{373.16}{T_K-1} + 5.02808 \times .4343\ \ln\ \left(\frac{373.16}{T_K}\right)$$

$$P_2 = -9.3816 \times 10^{-7}\ \left(10^{11.344}\ \left(1-\frac{T_K}{373.16}\right) -1\right)$$

$$P_3 = 8.1328 \times 10^{-3}\ \left(10^{-3.49149}\ \left(\frac{373.16}{T_K} -1\right) -1\right)$$

$$T_K = 5/9\ (T_F-32) + 273.16$$

$T_F$ = Temperature in degrees Fahrenheit

The saturation vapor pressure for water vapor over ice is given by:

$$P_I = 29.921 \times 10^{(P_1 + P_2)}$$

where:

$P_I$ = Saturation vapor pressure of water vapor over ice

$$P_1 = -9.09718\ \left(\frac{273.16}{T_K} -1\right)\ -3.56654 \times .4343\ \ln\ \frac{273.16}{T_K}$$

$$P_2 = .876793\ \left(1- \frac{T_K}{273.16}\right) + .4343\ \ln\ .0060273$$

$$T_K = 5/9\ (T_F-32) + 273.16$$

$T_F$ = Temperature in degrees Fahrenheit

The humidity data was analyzed by the same method used for the temperature data. The computer program and the solution are contained in the appendix. The solution yields the calibration curve defined by Y = 1.37X-9.5 and the 90% confidence limits are defined by Y = (1.37X-9.5) ± 11.5. The data and these lines are plotted in figure 6.

The accuracy of the Weather Service humidity measurements over the temperature and dew point ranges encountered varies from ± 4 at 30% relative humidity to ± 12 at relative humidities greater than 80 percent. Since the inaccuracy of the Weather Service dew point measurements is of the same magnitude as the random error for the 90% confidence level, the correlation between the station reading and the true relative humidity is uncertain.

Figure 6 indicates that hysteresis is present. This is caused by the slow response time of the human hair bundle.

A static test of the station accuracy was made at two points on the relative humidity scale. First, the hair bundles were saturated with distilled water and allowed to stabilize. The station indicated 75 percent relative humidity. Next, the weather station was placed in a plastic bag with desiccant to drop the relative humidity to near zero. The station indicated off the bottom of the scale by approximately 25 percent. Therefore, it is apparent that calibration was displaced by 25% relative humidity.

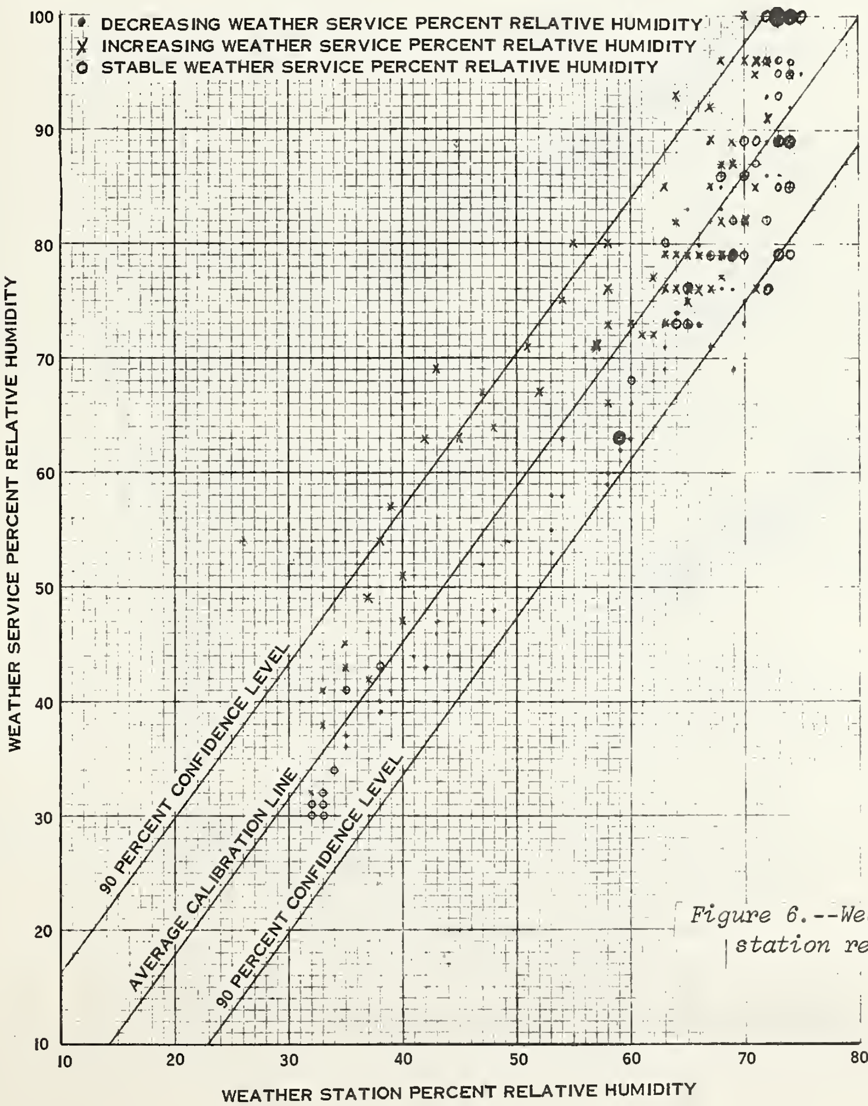


*Figure 6.--Weather Service vs. station relative humidity.*

Windspeed.--The wind velocity was read from the chart by taking the number of steps between 10 minutes before and 10 minutes after the time the Weather Service observation was made and dividing by 2. Because the threshold of the Weather Service anemometer was 3 knots, data taken for wind velocities less than 3 knots was ignored.

The windspeed data was analyzed by the same method used for the temperature data. The computer program and the solution are contained in the appendix. The solution yields a calibration curve defined by Y = .624X+4.4 and the 90% confidence limits are defined by Y = (.624X+4.4) ± 5. The data and these lines are plotted in figure 7.

If the systematic error was removed through calibration, the station reading would be within ± 5 mi/h of the Weather Service measurement 90% of the time. Since the Weather Service wind velocity is accurate to ± .5 knot, it is reasonable to assume that the station reading will be within ± 5 knots of the true windspeed.

Part of the error may be due to the 5 foot difference in elevation of the two anemometers. Also, the difference in time the measurements were averaged could cause discrepancies.

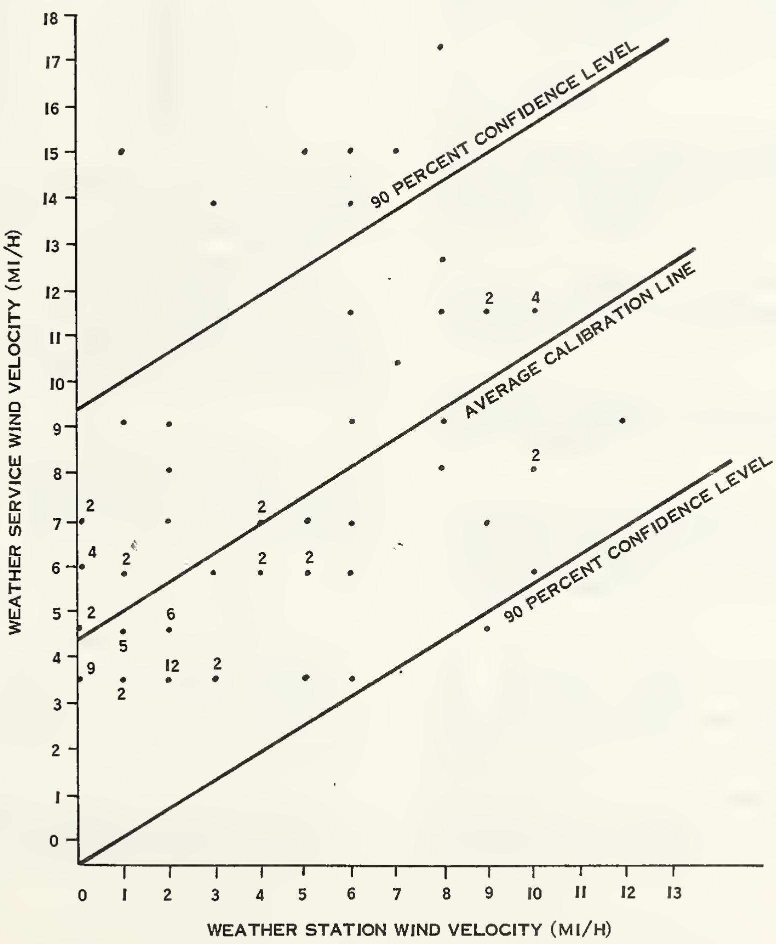


*Figure 7.--Weather Service vs. station wind velocity.*

Wind direction.--The station data was encoded as follows:

1 - North
2 - Northeast
3 - East
4 - Southeast
5 - South
6 - Southwest
7 - West
8 - Northwest

Because the Weather Service wind direction was recorded to the nearest 10 degrees, this data was assigned the following values:

| | | | |
|---|---|---|---|
| 1 - | 340° | through | 20° |
| 2 - | 30° | " | 60° |
| 3 - | 70° | " | 110° |
| 4 - | 120° | " | 150° |
| 5 - | 160° | " | 200° |
| 6 - | 210° | " | 240° |
| 7 - | 250° | " | 290° |
| 8 - | 300° | " | 330° |

Because the Weather Service wind vane had a threshold of 5 knots, comparisons were made for wind velocities of 5 knots or larger. Also, comparisons were limited to cases where the wind direction shifted one segment or less during the time interval of 10 minutes before to 10 minutes after the Weather Service observation.

A computer program was written to find the total number times the wind directions corresponded, were off by 1 segment, 2 segments, etc. This program and the solution are contained in the appendix.

The wind directions corresponded for 59% of the observations; were within 1 segment for 85% of the observations; and were within 2 segments for 91% of the observations.

Precipitation.--The precipitation measured by the Weather Service and the station is shown in table 1.

Table 1.--*Precipitation in inches*

| Date | Time | Weather Service | Station |
|---|---|---|---|
| 10-9-72 | 16:50 to 22:46 | 0.01 | 0.01 |
| 10-10-72 | 00:00 to 04:45 | 0.06 | 0.06 |
| 10-10-72 | 04:45 to 10:50 | 0.06 | 0.06 |
| 10-10-72 | 10:50 to 16:45 | 0.15 | 0.19 |
| 10-10-72 | 16:45 to 22:45 | 0.01 | 0.00 |
| 10-10-72 | 22:45 to 24:00 | 0.04 | 0.04 |
| 10-13-72 | 10:48 to 16:46 | 0.14 | 0.14 |
| | TOTAL | 0.47 | 0.50 |

The amount of data available was insufficient to analyze by statistical methods. However, it should be noted that the measurements compare very closely considering that the rain gages were a quarter of a mile apart.

User Comments

Both users felt that the general concept of the portable weather stations was good. However, they reported several problems.

One unit failed to operate as received and the electronics package had to be repaired.

The chart paper failed to advance on occasion because the drive sprocket holes ripped out.

The amount of energy left in the batteries was difficult to determine. Suitable chargers were not readily available and spare batteries were difficult to obtain.

Two men were required to extend and guy the anemometer mast. The stakes supplied to anchor the guys were unsatisfactory and one mast blew down.

The weight, bulk and fragility of the stations limits their use to sites accessible by road.

## CONCLUSIONS

1. The reliability of the portable weather stations was poor.

2. The accuracy was considerably less than what the manufacturer specified and the slow response time of the temperature and humidity sensors caused significant errors.

3. The size and weight of the stations limit installation mainly to sites accessible by road.

4. The batteries were difficult to service since a charger was not provided.

5. The anchor stakes for the mast guy cables were not suitable for use in some types of soil.

## RECOMMENDATIONS

1. The Forest Service should not purchase additional Model WS750 automatic weather stations.

2. If the need for a portable weather station still exists, a smaller and lighter station should be developed with the following considerations:

   a. The station should be designed so that telemetry could be readily added.

   b. The advantages of digital printout over an analog chart should be considered.

   c. Aspirated types of temperature and humidity sensors should be considered to reduce the response time.

   d. Rechargeable batteries should not be used unless two sets and a charger are supplied.

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OPERATION AND SERVICE MANUAL

MODEL WS750 AUTOMATIC WEATHER STATION

TABLE OF CONTENTS:

## MODEL WS750 AUTOMATIC WEATHER STATION

### I. INTRODUCTION

The WeatherMeasure Model WS750 Automatic Weather Station is a portable, electro-mechanical system for measuring and recording the following parameters:

1. Precipitation
2. Temperature
3. Wind Direction
4. Wind Run and Speed
5. Humidity

The Weather Station consists of the following major components:

1. Tipping Bucket Rain Gage with 60 feet of 2-conductor cable; WeatherMeasure Model No. P501 -- 1 each.

2. Contact Anemometer, 3-cup, 1/6-mile contacts; WeatherMeasure Model No. W163-E 1/6 -- 1 each.

3. Light Weight Vane with 8-segment switch; WeatherMeasure Model No. W165-8NS -- 1 each.

4. Crossarm Assembly; WeatherMeasure Model No. W1034CA -- 1 each.

5. Tower, 5-section, with guy wire; WeatherMeasure Model No. WS-750-T15.

6. Cable, 11-conductor, 60 feet; WeatherMeasure Model No. WS-750-C-11.

7. Recorder, strip chart, 5-channel with bimetal temperature sensor, hair hygrograph and event cams for wind speed, wind direction and precipitation; WeatherMeasure Model No. WS-750R -- 1 each.

8. Shipping and Storage Containers; WeatherMeasure Model Nos. WS-750-SC1 and WS-750-SC2 -- 1 each, 2 total.

Output from the sensors is recorded on a strip chart recorder employing an inkless, pressure-sensitive chart paper. A separate 2-inch wide channel is provided for each of the five outputs. The chart is driven by a pulse motor controlled by a tuning fork regulated clock and a high frequency switch. The clock chart drive mechanism has exceptionally low power requirements.

Power is supplied by a set of one lead-dioxide batteries with a total output of 4.5 ampere hours at 12 volts or two 6 volt 8 ampere hours. These batteries have an operational temperature range of -80°F to +175°F. The batteries are sealed and are fully rechargeable.

In use, the wind sensors are mounted on the crossarm assembly, which, in turn, is installed on top on the 15-foot sectional tower. No stand is provided for the precipitation gage, since each user may have a different requirement for elevation and exposure of the gage. Temperature and humidity elements are mounted on the rear of the recorder housing. The recorder case is equipped with four sockets and legs for field installation. The wind and precipitation sensors are connected to the recorder with the cables provided. This portable system can be set up in the field by one man in about two hours time.

The automatic weather station is particularly adaptable to micro-and meso-meteorological investigations. Its ready portability makes it a valuable instrument for environmental and ecological surveys associated with fire weather, pollution, agricultural operations, watershed hydrology, etc.

## II. GENERAL DESCRIPTION AND OPERATING PRINCIPLE

### A. Precipitation

The WeatherMeasure Model P501 Remote Recording Rain Gage is used to measure precipitation. This gage has a 20 cm ($\sim$8") orifice and uses the time proven tipping bucket principle.

The chrome-plated brass buckets are pivoted in such a manner that one bucket is always in position under the inlet orifice funnel. As the bucket fills, the weight of the water causes it to tip and empty into a drain tube at the bottom of the gage. The tipping motion automatically swings the second bucket into position under the funnel and simultaneously causes a mercury switch to make momentary contact.

When properly calibrated, each tip of a bucket is equivalent to 0.01 inches of precipitation or 8 c.c. of water. The calibration of each bucket can be changed by raising or lowering the bucket stops (Item 3, Figure 1) or by changing the position of the bucket counterbalance weight (Item 17, Figure 1). Normally, calibration is performed by raising or lowering the stops.

TIPPING BUCKET RAIN GAUGE
P-501

| No. | Item |
|---|---|
| 1 | Case Clip |
| 2 | Water Drain |
| 3 | Calibration Assembly |
| 4 | Minor Bucket Support |
| 5 | Tipping Bucket Assembly |
| 6 | Lower Funnel |
| 7 | Two Wire Condudtor |
| 8 | Terminal Board |
| 9 | Mercury Switch |
| 10 | Tipping Assembly |
| 11 | Major Bucket Support |
| 12 | Switch Support Assembly |
| 13 | Level |
| 14 | Base Casting |
| 15 | Case |
| 16 | Insect Screen |
| 17 | Adjusting Weight |

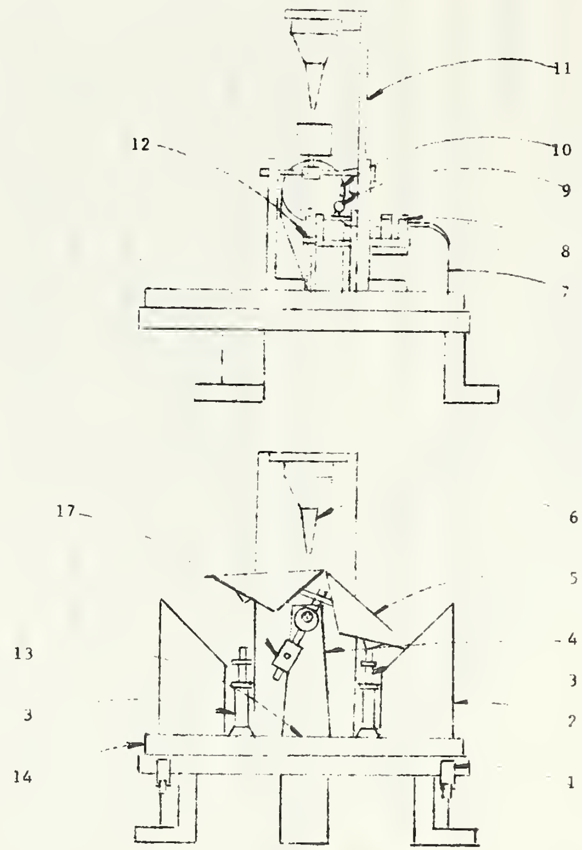



FIGURE I

WEATHER MEASURE
a division of KMS Industries, Inc.

Sixty feet of 2-conductor cable is provided with the rain gage. This cable is connected in series with the battery power supply and precipitation event pen in the recorder. Each time the mercury switch makes a momentary contact the event pen advances one step on the recorder chart.

The precipitation channel on the recorder chart has a range of 10 steps full scale, which is equivalent of 0.10 inches of precipitation. When the event pen reaches either extreme of this channel (after 10 steps), the helix drive reverses the direction of pen travel.

B. Temperature

A curved bimetal strip is used to measure temperature. The bimetal is mounted at the rear of the recorder case. It is protected by a ventilated cover to permit free circulation of air.

Changes in air temperature distort the bimetal since the two metals of which it is composed have different temperature expansion coefficients. The resulting differential expansion causes the bimetal to flex. By means of a linkage system, distortion of the bimetal is transferred to a pen arm which produces a trace record in the temperature channel on the chart.

The temperature pen is spring loaded and raised off the chart approximately 1/8 inch and is pressed into the paper at one minute intervals by a solenoid located at the side of the case. The trace on the paper at one minute intervals should appear as almost a solid line.

The temperature channel on the chart has a range from $+10^{\circ}F$ to $110^{\circ}F$. By adjustment of the linkage, other $100^{\circ}F$ ranges can be measured. Accuracy of the bimetal is $\pm 1\%$ of full scale.

Details of the temperature assembly are shown in Figure 2. Item 5, Figure 1 is the temperature calibration adjustment screw.

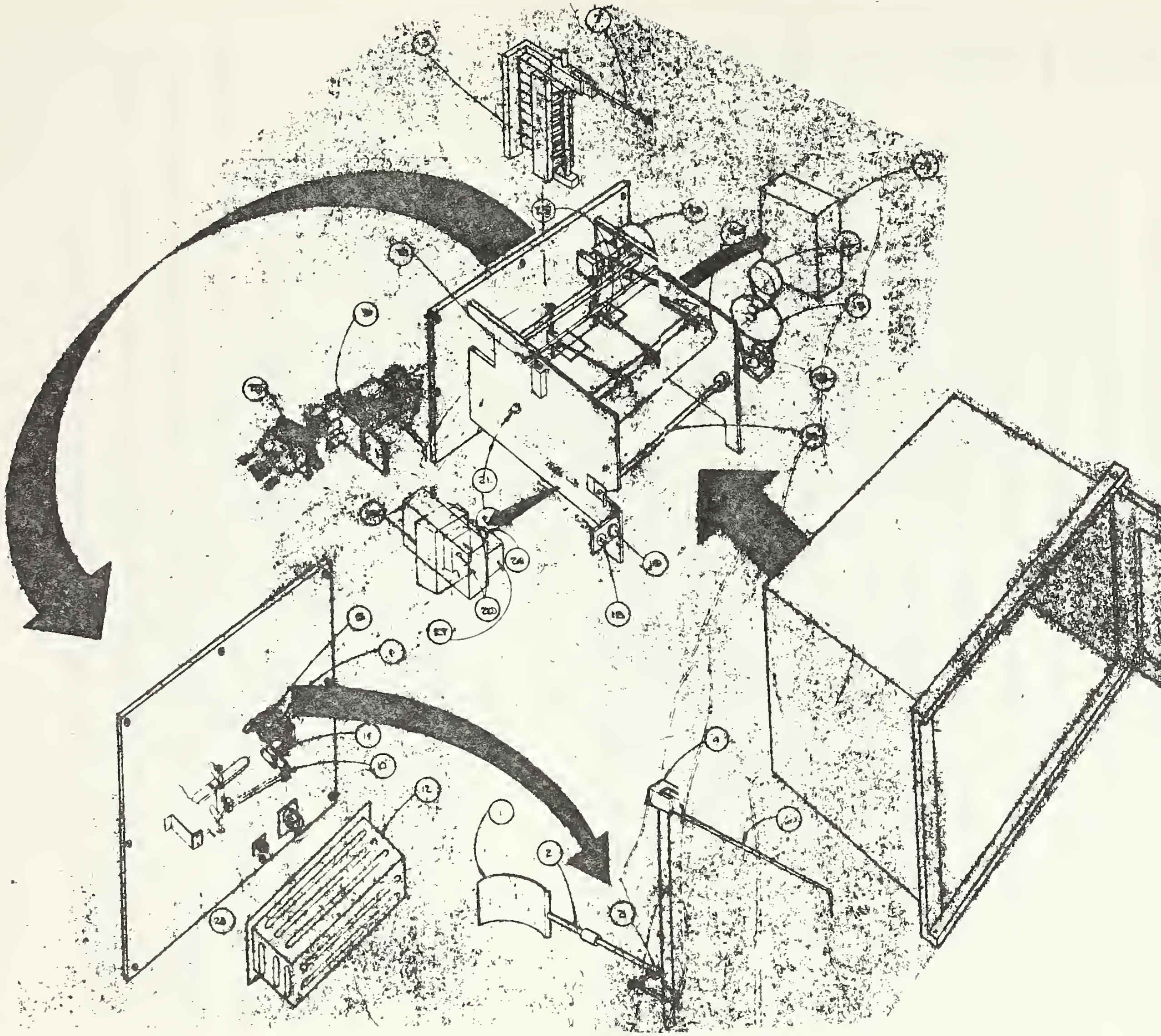


FIGURE 2

## ITEM LIST

1 – TEMPERATURE BIMETAL
2 – THERMOGRAPH DRIVE LINKAGE
3 – THERMOGRAPH LINKAGE ADJUSTMENT
4 – STYLUS CLEVIS
5 – TEMPERATURE ADJUSTMENT
6 – THERMOGRAPH STYLUS
7 – WIND DIRECTION STYLUS
8 – ACTUATOR
9 – PPECIPITATION MOTOR
10 – HUMIDITY
11 – HUMIDITY ADJUSTMENT
12 – TEMPERATURE & HUMIDITY SHIELD
13 – WIND DIRECTION MECHANISM
14 – HIGH FREQUENCY SWITCH ASSEMBLY
15 – DRIVE PULLEY
16 – CHART DRIVE ROLLER
17 – CHART TAKE-UP ROLLER
18 – START & STOP SWITCH
19 – FUSE HOLDER
20 – CLOCK STARTER
21 – CHART FEED ROLLER
22 – CHART TAKE-UP ROLLER
23 – STEPPING MOTOR
24 – CLOCK SPEED ADJUSTMENT
25 – HUMIDTY STYLUS
26 – PULSE MOTOR
27 – CLOCK
28 – HAIR BUNDLE
29 – ELECTRONIC PACKAGE

C. Wind Direction

A light weight vane, WeatherMeasure Model No. W165-8NS with an 8-segment switch and silver-carbon nonshorting wipers is used to record wind direction.

As the vane rotates, the wipers complete a circuit for each of the 8 segments of the switch, whichever is appropriate to the direction in which the vane is pointing. Each segment of the switch is wired in series with the recorder battery power supply and one of the 8 cams used to record direction with one pen. Completion of the circuit for any of the 8 cams causes its respective solenoid to activate and rotates the pen on the chart paper. As a precaution against continued current drain, an electronic circuit limits the maximum number of pulses to the solenoids to one every minute.

Vane construction consists of an anodized aluminum housing; stainless steel counterbalance, bearings and shaft, and a light weight airfoil foam plastic tail. A cannon-type connector is provided at the base of the vane body for ease in mounting and providing electrical connections.

Forty feet of 11-conductor cable is provided to connect the vane (9 conductors required) and the anemometer to the recorder.

In use, the vane is connected to a crossarm assembly, which is mounted on top of the 15-foot mast.

D. Wind Run

A low threshold, 3-cup contact anemometer, WeatherMeasure Model W163-E 1/6 is used to measure wind run. A contact (switch closure) is made for each 1/6 mile of wind run.

The 3-cup assembly consists of white plastic cups molded onto a stainless steel frame. Rotation of the cups moves a gear train which, in turn, activates a micro-switch for each 1/6 of a mile of wind run. The micro-switch in turn is wired in series with the battery power supply and the wind run event pen. The wind run event pen is identical to the precipitation event pen. It

advances 10 steps and then reverses direction when the end of the recording channel is reached.

To prevent excessive current drain in the event calm conditions are reached simultaneous with a switch closure, an electronic circuit is provided which permits only a momentary discharge of current for each switch closure.

The number of steps (or events) for a 10-minute time interval is an index of the average wind speed in miles per hour.

The anemometer body is constructed of anodized aluminum. The bearings and shaft are stainless steel. A cannon-type connector at the base of the anemometer body permits ease in mounting and electrical connections.

Forty feet of 11-conductor cable is provided to connect the anemometer (two conductors required) and vane to the recorder.

In use, the anemometer is connected to a crossarm assembly, which is mounted on top of the 15-foot mast.

E. Relative Humidity

Relative humidity is measured by a 3-bundle, human hair sensor mounted on the back of the recorder case. It is protected by a ventilated cover which permits free circulation of air.

By means of suitable linkage, expansion and contraction of the hair bundles is transferred to a pen arm which produces a trace on the pressure sensitive chart paper. As a result of the mechanical linkage, the trace is essentially linear over the operationally reliable range.

The humidity pen is spring loaded and raised off the chart approximately 1/8 inch and is pressed into the paper at one minute intervals by a solenoid located at the side of the case. The trace on the paper at one minute intervals should appear as almost a solid line.

Human hair has a remarkable reaction to changes in moisture content. Its length is a function of the relative humidity and not of the actual water vapor content of the surrounding air. A change of 0.1"Hg vapor pressure at 32°F produces the same change in length as does a vapor pressure of 1.0" at 98°F. The length of the human hair increases by about 2 1/2% when the relative humidity changes from 0 to 100%. For all practical purposes, the tension imposed on a hair bundle by the pen mechanism does not influence the response to change in RH. (Hair hygrometers are not recommended for use in the Arctic or at high altitudes.) At low temperatures, there is a large time lag in response to changes in RH. For those users of the WS-750 Automatic Weather Station who are interested in more detailed information on hair hygrometry, the publication HANDBOOK OF METEOROLOGICAL INSTRUMENTS, M.O. 577, Air Ministry Meteorological Office, Her Majesty's Printing Office, London, is recommended.

Accuracy is about +5% between 20% and 100% RH and about +3% from 5% to 20%. The condition of the hair bundles determines their sensitivity. They should never be touched, as oil from the skin will affect calibration. Periodic washing with a camel hair brush and distilled water is suggested to remove dust.

A calibration screw, Item 11, Figure 2, is used to adjust the relative humidity calibration.

### F. Recorder

The 5-channel strip chart recorder is housed in an aluminum case designed to permit outdoor installation on legs, installation in a cotton region type instrument shelter, or mounting in an exterior wall of a building. The hinged access door has a plexiglass window to permit chart inspection without opening the door.

Construction is such that removal of eight screws on the back panel permits the entire chart drive assembly with event pens to be removed from the case as an integral unit.

1. Chart Drive

A battery-operated, tuning fork controlled clock coupled to a frictionless, high frequency switch (Item 14, Figure 2) provides a precisely timed square wave pulse to the chart drive pulse motor (Item 26, Figure 2) at 30-second intervals. The pulses are produced by rotating a notched aluminum disc between the oscillator and receiver of the high frequency switch. Each time a notch passes between the oscillator and receiver, a pulse is produced.

At a chart speed of 3/4 of an inch per hour, 120 pulses per hour are delivered to the pulse motor providing essentially a continuous chart flow. Chart speed can be changed by changing the number of notches in the disc.

The chart moves from a supply roll at the rear of the chart housing over the platen and sprocket drive (Item 16, Figure 2) to a take-up spool (Item 17, Figure 2) driven by a spring belt.

Chart movement is initiated by turning on the battery power switch (Item 18, Fiture 2) and then pulling out and releasing the clock start lever (Item 20, Figure 2).

Check chart speed. If speed is slightly fast or slow, adjust clock speed by means of the lever provided (Item 24, Figure 2). It is possible for the clock to occasionally operate on a harmonic of the tuning fork frequency and thereby drive the chart at two to three times rated speed. If this occurs, stop the clock by turning off power, turn on the power and restart the clock.

2. Chart Paper

Chart paper can be supplied in any length rolls up to 150 feet. At a rate of 3/4 in/hr and an operational period of eight days, a chart length of 12 feet would be required.

The chart number for a chart with 4 information channels, as described previously in this manual is CWS-750-12. The last 2 digits indicate the length of the chart rolls.

Chart installation is covered in Section III-C of this manual.

3. Battery Power Supply

Battery drain depends primarily on the rate at which events are recorded. The approximate current drain per event is listed below:

| | | |
|---|---|---|
| a. | Precipitation | 900 msec/amps/event |
| b. | Wind Run | 480 msec/amps/event |
| c. | Direction Change | 420 msec/amps/event |
| d. | Temperature & Humidity Solenoid | 100 msec/amps/event |

Chart drive current drain is approximately 10 ma.

The type and number of batteries used to power the station, therefore, varies with the length of recording period desired and the average wind speed and precipitation anticipated at the measurement site.

It is recommended that either 2 each Globe Gel/Cell Batteries, Model GC 1245-1, 4.5 amp-hr, 12 volt lead-diozide batteries be used in parallel or 2 EL Power, Model 680 6 volt 8 amp-hr in series. The batteries have a gel electrolyte and are permanently sealed. The operating range of the Globe batteries is from -80°F to +175°F. At -30°F approximately 50% of rated capacity is available and in the EL power -76°F to +140°F and is rated at 68°F. Below this temperature battery capacity decreases.

A set of 4 fully charged batteries will provide about 30-60 days of continuous operation. Battery harness will require modification to add 2 batteries.

Batteries may be recharged with a 12VDC trickle charger, but the charge rate must not exceed 0.675 amps per battery. When batteries reach 14.4 volts per battery and charging rate has dropped to 90 mills per battery, the batteries are fully charged. NOTE: Battery harness connector is shipped from the factory for GC batteries operating in parallel. If EL batteries are used, wiring harness must be modified to put batteries in series.

4. Power Switch

All pen drives and sensor circuit are automatically energized when the power switch (Item 18, Figure 2) is turned to the "on" position.

5. Recorder Legs

The recorder case is provided with four sockets on the bottom into which legs may be mounted. It should be recognized, however, that when the case is fully exposed, both the temperature and humidity elements may be influenced by the micro-environment created by the mass of the case. Solar radiation absorption can lead to high temperature records and slow response to changes in the ambient. It is suggested that where sensitive data are required the recorder be mounted inside of a standard "cotton region type" instrument shelter, such as the WeatherMeasure Model IS1, or that some other protection from direct solar radiation be provided, which will not interfer with the free flow of air around the temperature and humidity sensors. If not mounted in a "cotton region type" shelter, the temperature and humidity elements should be oriented to the north.

G. Mast

A 15-foot, 5-section, telescoping aluminum tubular mast with a mounting flange on the base section and guy mounts at 6 and 15 feet is standard equipment. Guys and anchors are furnished. A 3-foot T-mount crossarm for support of the anemometer and wind vane is mounted on top of the mast by a simple set screw fastener.

## III. INSTALLATION

A. Precipitation Gage

Since the automatic weather station will be used, in most applications, for short-period, micro- or meso-climatological surveys, site selection for instrument installation will be determined by the environment to be sampled. In selecting a site for the P501 Rain Gage, consideration should be given to providing uniform exposure to all compass points unless the nature of the inves-

tigation dictates otherwise. Regardless of site selection, the gage must be mounted level and firmly. Several short lengths of heavy timber placed on the ground or partly imbedded and levelled makes an ideal base. The gage is 22 inches high and, therefore, the orifice is above splash height so it may be mounted at ground level. In normal practice, if there are obstructions in the area, the gage is usually set up at a distance of 1 1/2 times the height of the nearest obstruction, as a minimum.

After setting up the gage, the 2-conductor lead is connected, without regard to polarity, to the appropriate terminals on the gage and the recorder.

B. Mast, Erection, and Instrumentation

1. Stretch out guy wires. Drive in guy anchors on a 9 foot diameter circle spaced at 120°.

2. Assemble the vane and anemometer on the cross arm and mount on the first section of the mast. Carefully protect these two delicate instruments at all times.

3. The tower is a telescoping type in 5 sections of 3 feet each. The tower is erected by first establishing a good level base at least as large as the bottom mounting flange. When the tower flange is established at a good level altitude, the first section is moved vertically until the spring loaded pin in that section snaps in place and the section cannot be moved up or down. The section is now rotated in either direction until locking pin snaps into its locking hole and cannot be turned any further.

The above operation is repeated with each section until the tower is fully extended. The tower is now rotated until the vane is pointing north.

4. Tighten guys using attached turn buckles to level the instruments and plumb the mast. Use a carpenter or mason's level to check the mast.

5. Run cable to recorder.

C. Recorder Mounting

1. Install tubular legs in the sockets on the base of the recorder case. Set up recorder on firm ground or on a previously prepared level base. The recorder should be level.

2. Alternatively, set up a "cotton region type" instrument shelter (WeatherMeasure IS1 is suggested). Install the recorder without legs in the shelter, leveling with shims under the leg sockets if necessary. The leg sockets provide clearance between the base of recorder and floor of shelter and thus improve ventilation. When installed in a shelter, it is desirable to convert the rear shelter panel into a door to permit access to the temperature and humidity elements of the automatic weather station. The shelter should be mounted and the recorder installed so the humidity and thermal sensors are to the north; i.e., the shelter front access door and recorder door facing south.

3. Connect all cables by mating cannon plugs on the cable and on the rear of the recorder.

4. Install chart. Place chart roll in rear position beneath platen and drive roll in chart housing (Item 21, Figure 2). Bring paper up and over platen and drive cylinder. Mesh perforations in paper with sprocket teeth on drive cylinder (Item 16, Figure 2), carry paper down to take-up cylinder (Item 17, Figure 2) and tape to cylinder. The take-up cylinder is cardboard and is force-fitted with minimum friction on a spindle that meshes with the best driven gear on the right, exterior side of the chart housing (Item 22, Figure 2).

5. Adjust temperature pen, if necessary, to correspond with the ambient in temperature channel on chart by a slight turn of the large slotted adjusting cam which is centered within the curved, bimetallic element (Item 5, Figure 2).

6. Adjust humidity register pen, if necessary, to correspond with ambient in the chart channel by turning the adjusting screw at end of hair bundle clamp located just beneath temperature unit adjusting can (Item 11, Figure 2).

7. All other pens should be in satisfactory adjustment on delivery. Their position with reference to a base line is not critical to a satisfactory record.

8. Check drive belt for chart to see that it is on both sprocket drive and take-up roll pulleys.

9. Step the wind run pen to far right of chart section by reaching in from right side of recorder between chart housing and recorder housing and moving large gear (Item 23, Figure 2), right side, until pen is in desired position. Step the precipitation recording pen to far left of chart section by reaching in between housings on left side of recorder and moving the gear on stepping switch by hand (Item 23, Figure 2), left side.

10. Move temperature or humidity pen by hand to make a base mark and enter time on chart with pencil or ball point pen.

11. Turn on master switch (Item 18, Figure 2) to energize sensors and recorder.

12. Pull and release starter button on clock to start pulser and activate the chart drive stepping motor (Item 20, Figure 2).

The automatic weather station should be fully operational after carrying out the above installation instructions.

## IV. ADJUSTMENTS

### A. Precipitation Gage

Check adjustment of the tipping bucket by carefully pouring 8.0 ml (cubic centimeters) of water into the small funnel after removing outer case. The bucket should just tilt and discharge when the last drop or two of water drains from the funnel into the bucket. For calibration purposes, multiples of the 9.0 ml volume may be used for corresponding 0.01-inch equivalents of water. Each bucket should be checked. If both buckets tilt when either more or less than the 8.0 ml of water is added (i.e., when the sum for both buckets is more or less than 16 ml), adjustment of the threaded rods centered below the pair of buckets, or the bucket stops, is required (Item 3, Figure 1). To reduce the amount of water required to tilt the buckets, screw

the rod upward. Turning the adjustment so it moves downward on the threaded rod will increase the discharge capacity of both buckets. If the sum of the discharge of both buckets is 16.0 ml, but one bucket requires more and the other less than 8.0 ml to tilt, then the stop screws (Item 3, Figure 1) must be adjusted--upward to reduce and downward to increase volume held by a bucket before tilting. The P501 Gage has been carefully calibrated and adjusted before shipment. It should not require calibration or adjustment by the customer for many years unless damaged in use. If precision data are desired and the mechanism appears to be damaged, it is recommended that the gage be returned to WeatherMeasure for recalibration.

B. Temperature Unit

The bimetallic sensor has been adjusted for linearity of response before delivery of the automatic weather station to the customer. The operator may find it necessary to adjust the pen to the correct temperature line on the chart. This should be done by comparing the trace of pen position with a good mercurial thermometer. Pen adjustment can be made by turning the slotted cam (Item 5, Figure 2) slowly and carefully until the pen is indicating the correct temperature. The set range when the station is delivered is +10°F to +110°F. This range may be shifted upward by 10°F or downward by 20°F without appreciable change in linearity of record. Lower or higher range is obtained by moving the lower connector block on the thrust lever froward or back ward (Item 3, Figure 2). Release the Allen head screw. Slide block forward or backward until pen shaft is approximately equal to the number of degrees of change in total range and in the direction of range change desired. Tighten set screws and move pen arm to selected ambient position on chart by loosening set screw in upper block (Item 4, Figure 2) and moving pen as required. Tighten set screws. Minor adjustment is

made by turning large slotted head cam (Item 5, Figure 2) so the ambient temperature or test chamber temperature is being registered at desired position on chart.

C. Wind Direction Unit

The eight cams in this unit (Items 7 & 8, Figure 2) are activated by brush contacts in the vane. The multiconductor cable is wired to the vane before delivery and when the cannon plugs on cable and recorder are mated, the pens are connected to the proper segment of the split ring armature. It is necessary only to orient the vane on the support arm so the indicator on the vane housing points north. Pens are adjusted before delivery and should not require further adjustment unless mechanically damaged.

D. Wind Run and Speed Unit

The anemometer has been adjusted before delivery of the station. It makes one contact for each 1/6 mile of wind travel. The gear train and switch mechanism are a permanently assembled unit and no adjustment can be made by the user. If damaged, or if faulty operation is encountered, the unit must be returned to WeatherMeasure for repairs or replacement.

The wind run pen steps across the appropriate channel on the chart in ten steps, each step representing 1/6 mile of wind travel, and then reverses. When starting the recorder, the pen may first be stepped to the upper or lower base line by reaching in between housings on right side of recorder and actuating the large gear (Items 9 & 23, Figure 2) on the rotary solenoid stepping switch by hand, as described in III-C of this manual. Both precipitation and wind speed records are produced by an identical pair of stepping pens and adjustment procedures are the same for both. An exploded view of only one of the stepping mechanisms is shown in Figure 2.

E. <u>Humidity Unit</u>

The humidity unit has been adjusted to provide a trace with good linearity of record before delivery of the station. The only adjustment required may be a minor movement of the pen to insure that the trace is whthin the humidity channel base lines and the pen is adjusted to the correct chart line for the humidity being recorded. This adjustment can be made by a slight turn of screw (Item 11, Figure 2). It is suggested that a calibrated hygrothermograph, such as WeatherMeasure Model H311, be used as a reference standard in the field for adjusting the chart position of both the humidity and temperature pens on the automatic weather station. A sling psychrometer may be used, along with the proper psychrometric tables to calibrate and adjust the hygrometer unit, if desired. It is recommended that calibration and adjustment with a sling psychrometer be made only at temperatures above the freezing point in order to avoid the need for use of psychrometric tables for temperatures below the freezing point.

F. <u>Chart Timing</u>

The clock has been accurately timed before shipment of the automatic weather station. If retiming becomes necessary, the chart roll should be temporarily removed to provide access to the pulse timer (Item 14, Figure 2). Open the white plastic cap over the time adjustment screw by sliding cap sideways (Item 24, Figure 2). With a small flat-nose pliers turn adjusting screw toward the "slow" or the "fast" indicators as required. Only a very slight movement of the adjusting screw is required. Replace chart and enter a time mark by mvoing one of the pens. Time for at least 12 hours and readjust if necessary.

If a major change in timing occurs, or if the chart runs erratically, and the difficulty cannot be attributed to friction in the drive mechanism, the recorder should be returned to WeatherMeasure for service.

G. Miscellaneous Adjustments

1. All sensor instruments should be leveled when installed and maintained level during the period of desired record. Failure to maintain the wind instruments in a level position may produce an erratic record due to lack of balance and resulting interference with the low threshold response of the system. (The recorder should be installed in a reasonably level position.)

2. A poorly legible wind speed, wind direction or precipitation trace on the chart may be corrected by increasing the spring tension on the pen with the adjustment screw provided in the pen pivot blocks.

## V. MAINTENANCE

A. Precipitation Gage

The orifice and funnels should be kept clean. Leaves, insects, and other debris should be removed as frequently as possible. Any dirt in the tipping buckets should be washed out or wiped out with a soft cloth or cellulose sponge. After several months of use, the bucket and switching mechanism pivots may be lightly oiled with a low temperature, light silicone oil. Pivot bearings for the mercury switch should always be loose enough to permit free movement of switch axle.

B. Thermograph

Remove cover and inspect the bimetallic unit occasionally to see that there is no debris, or insect accumulation. The various pivots and bearings should be periodically cleaned and lightly oiled with silicone oil.

C. Wind Direction System

Once each year the carbon brushes should be inspected and replaced if necessary. All other moving parts have been permanently lubricated and should require little maintenance. Bearings should be inspected to insure freedom of movement of the vane shaft. Replace if necessary.

D. Wind Run and Speed Unit

The cups may be removed for inspection of the upper miniature bearing by loosening the small set screw in the side of the spindle cap in which the cup arms are mounted. Gears and bearings may be inspected by loosening the small set screw in the lower housing and dropping out the gear train. Since the anemometer was permanently lubricated during construction, it is not considered advisable to dissassemble it for periodic inspection unless there is reason to believe a malfunction exists. Replace bearings if shaft does not turn smoothly.

E. Hygrograph

The hair bundles should be washed at least once a month, more often if used in a dusty or chemically polluted environment. The hair bundles may be washed in place using a camel hair brush and distilled water. When fully saturated with distilled water,the pen should read 100%RH. When the hair bundles are being cleaned the instrument can be recalibrated by adjusting the pen to the 100% base line by loosening Allen head screw (Item 25, Figure 2) and rotating pen arm on the vertical axis. Tighten screw after adjustment. All moving parts should be cleaned and lightly oiled periodically.

F. Recorder and Batteries

During periods of continuous operation the batteries should be recharged weekly. Charging can be done with any 12VDC source having a maximum output of 675 ma (0.675 amps). The 4 batteries have a full-charged capacity of 18 amps and at the maximum charge rate of 0.675 amps at least 24 hours of charging will be required to bring discharged batteries up to full charge. The battery is fully charged when terminal voltage reaches 14.4 volts and the charging current is less than 90 mills.

All internal moving parts of the recorder have been permanently lubricated and should require minimal maintenance service for several years. It is strongly recommended that the entire automatic weather station be returned to WeatherMeasure for maintenance and adjustment at least once every two years, or more frequently if used in an adverse environment.

## VI. SPECIFICATIONS

### A. Precipitation Gage

| | |
|---|---|
| Orifice | ~8 in. diam. (20 cm) |
| Calibration | 0.01 in. or 0.25 cm |
| Sensor | Tipping buckets |
| Switch | Mercuty |
| Accuracy | 0.5% calibrated at 0.5 in/hr |
| Color | White |
| Size | 20 in. high X 12.5 in. diam. |
| Weight | 15 lb. |
| Chart Read-Out | 0.01 in. |

### B. Temperature Sensor

| | |
|---|---|
| Sensor | Bimetallic strip, age cured |
| Range | $100^{\circ}F$ |
| Scale | $+10^{\circ}F$ to $+110^{\circ}F$ standard; other scales from $-20^{\circ}F$ to $+80^{\circ}F$ up to $+30^{\circ}F$ to $+130^{\circ}F$ by adjustment |
| Accuracy | $\pm 2^{\circ}F$ |

### C. Wind Direction Vane

| | |
|---|---|
| Material | Aluminum housing; plastic tail, stainless steel shaft, bearing, and counterbalance. |
| Threshold Response | 0.75 mph |
| Chart Read-Out | 8 compass points through 8 separate pens |

D. Anemometer

| | |
|---|---|
| Cups | 3, light weight plastic |
| Diameter | 6.5 in (3-1/4 in, cup center to shaft center each arm) |
| Shaft and Bearings | Stainless steel |
| Transmitter | Gear train and micro-switch with 1/6 mile contact |
| Chart Read-Out | 1/6 mile steps; steps/10 min = mph |

E. Humidity Sensor

| | |
|---|---|
| Range | 0-100% RH nominal; 5-90% RH operational |
| Accuracy | +3% between 5% and 20% RH<br>+5% between 21% and 90% RD |
| Sensor | 3-bundle group, human hair |
| Chart Read-Out | 2% RH approximately |

F. Recorder

| | |
|---|---|
| Power Supply | 12 volt, lead-dioxide battery, 18 amp-hr capacity, rechargeable or two 6 volt 8 amp-hr capacity, rechargeable |
| Operating Period | 8 days per roll |
| Chart Drive | Sprocketed platen with belt from pulse motor |
| Chart Speed | 3/4 inch per hour, standard; other speeds on special order |
| Chart Channels | 5, each 2 inches wide |
| Chart Paper | Inkless, pressure sensitive |
| Chart Length | 15 feet, 8-day at 3/4 in/day |

## VIII. WARRANTY

All instruments are tested prior to shipment and are warranted for one year against defects in material and workmanship. Should any instrument or part prove to be defective, then upon written notice and return of the unit, the supplier will, at his option, repair or replace the defective unit and return it transportation prepaid.

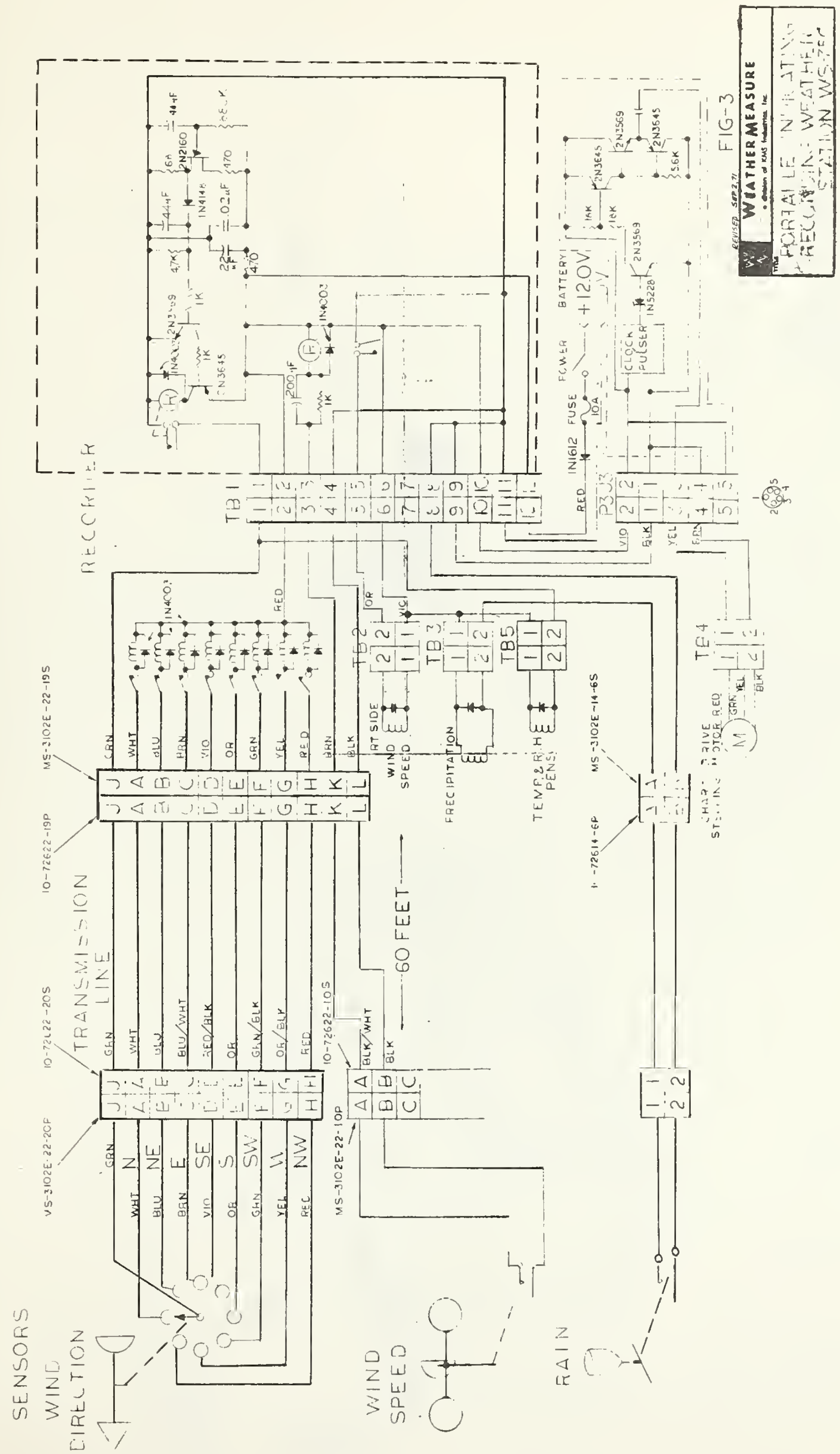
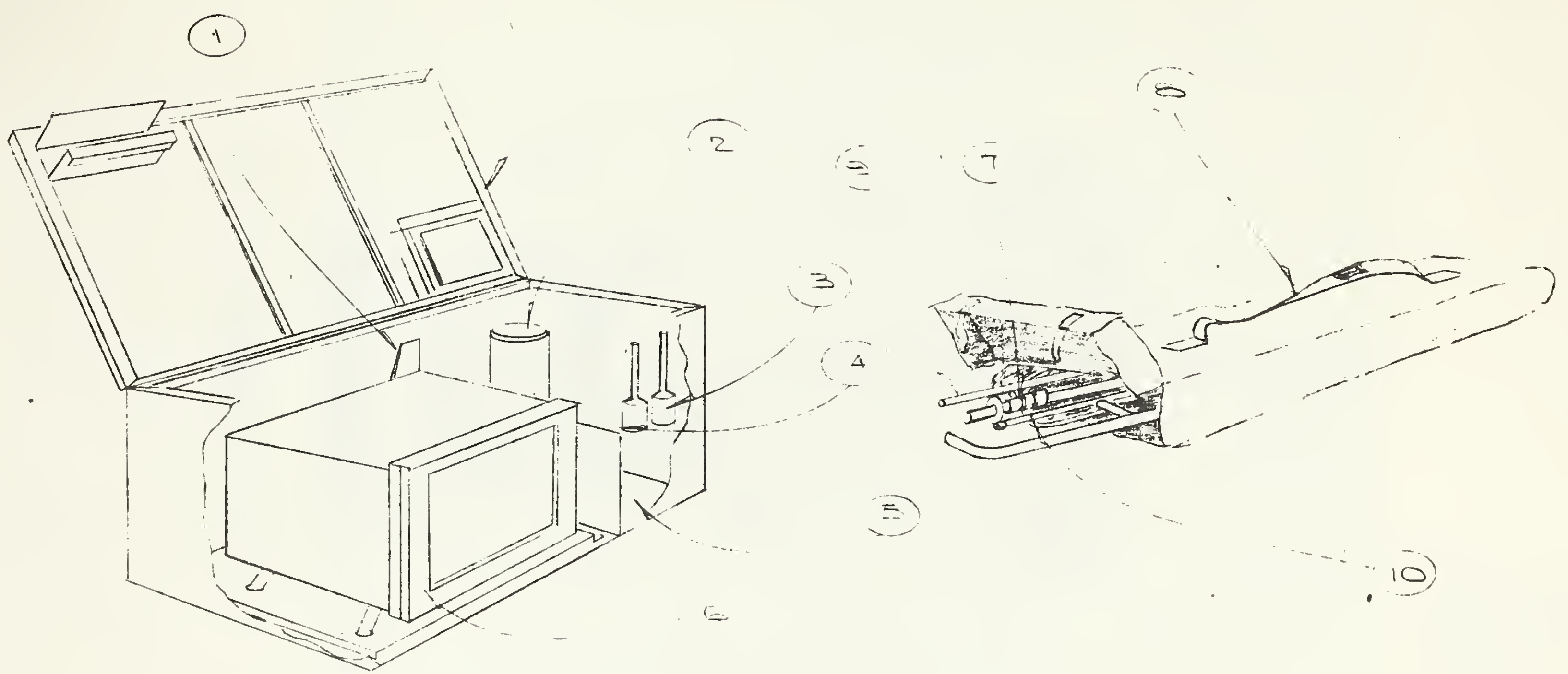

SENSORS
WIND DIRECTION
WIND SPEED
RAIN
TRANSMISSION LINE
60 FEET
RECORDER
TB1
TB2
TB3
TB4
TB5
WIND SPEED
PRECIPITATION
TEMP & RH PENS
CHART DRIVE MOTOR
FUSE
POWER
BATTERY
+12.0V
CLOCK PULSER
WEATHERMEASURE
FIG-3

FIGURE 3

WS 750 SC-1




5 [illegible] ETC.

4 WIND VANE

3 WIND ANEMOMETER

2 [illegible]

1 TAIL

10 [illegible] CABLE STORAGE

9 [illegible]

8 CANVAS CONTAINER

7 TOWER

6 RECORDER

SHIPPING & STORAGE CONTAINERS
MODEL WS 750 WEATHER STATION
FIG. 4

WEATHER MEASURE CORPORATION

FIGURE 4

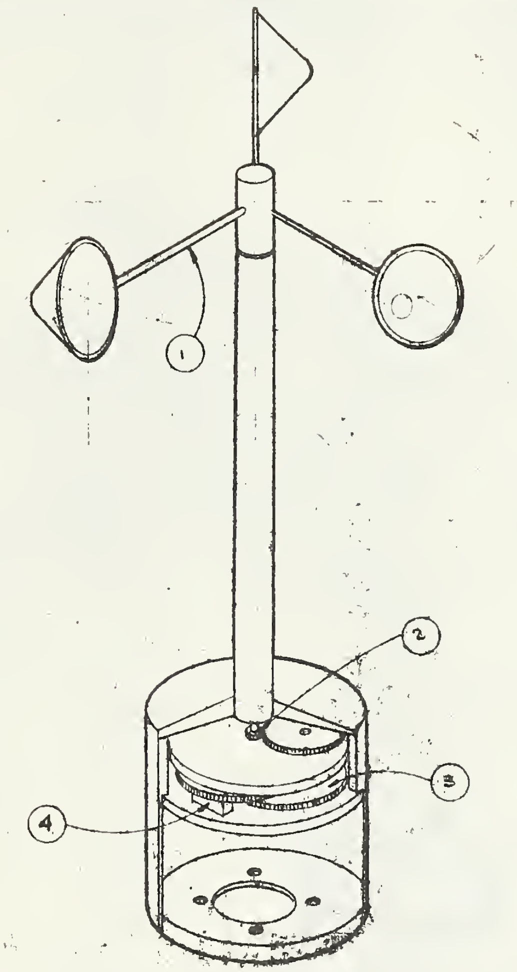
ITEM DESCRIPTION

1– CUP ASSEMBLY

2– DRIVE GEAR

3– REDUCTION GEARS

4– MICRO-SWITCH

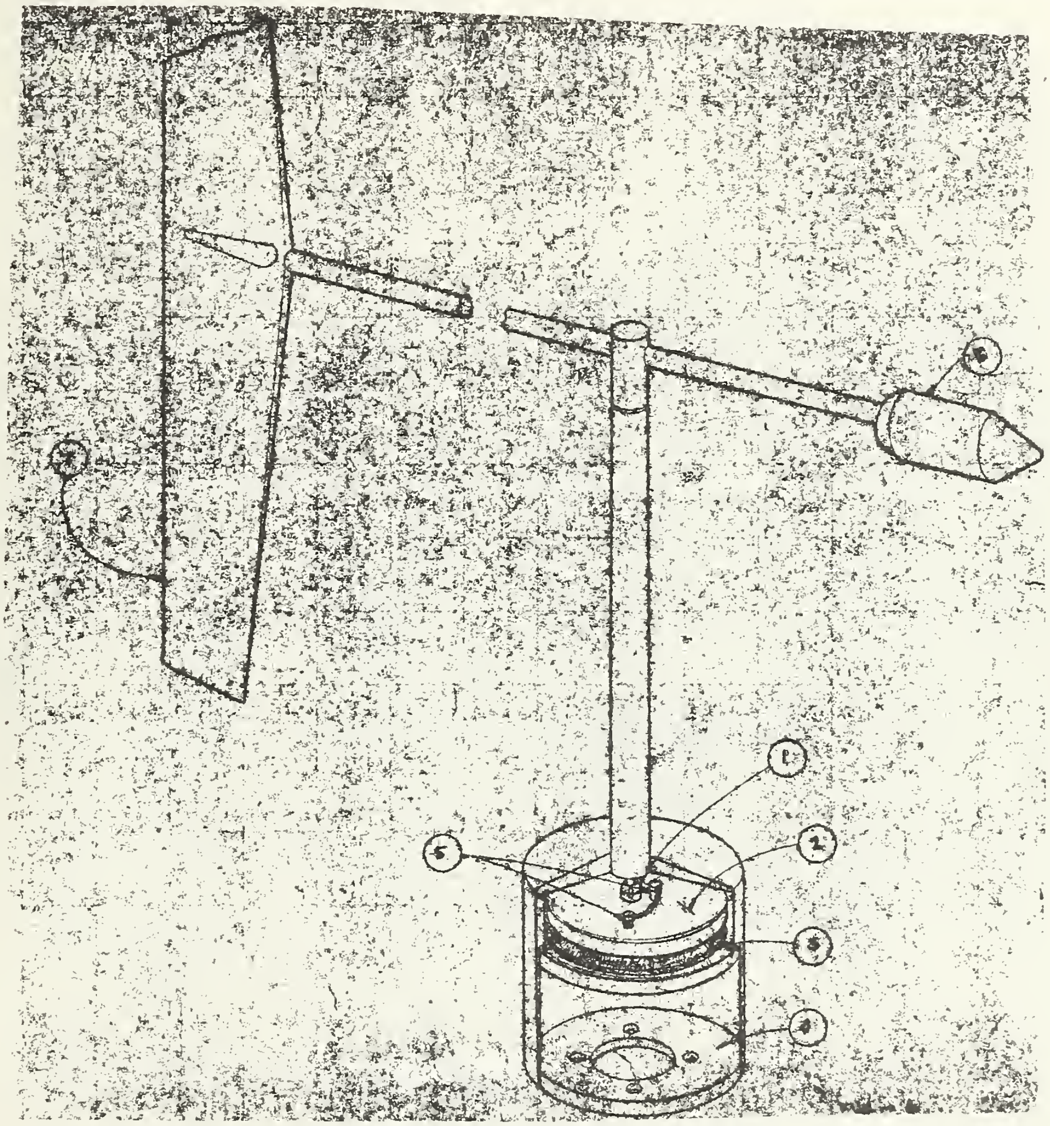



CONTACT ANEMOMETER
MODEL NO. W103–6C

FIGURE 5

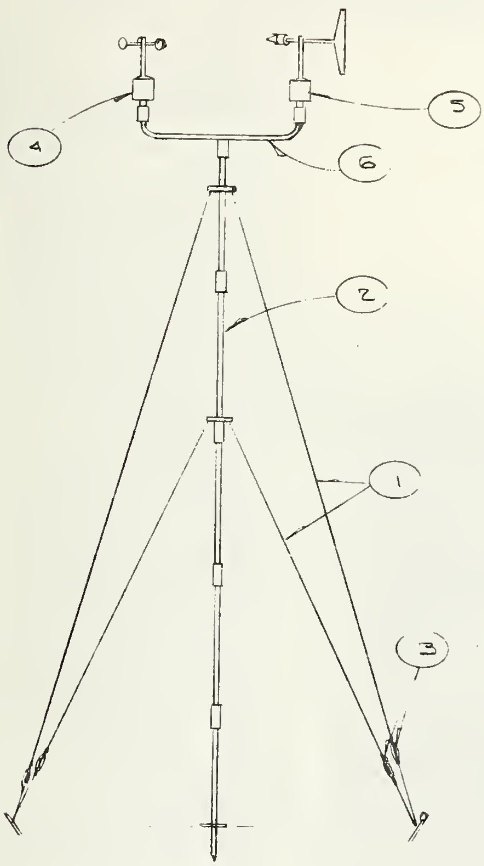
ITEM DESCRIPTION

1 – SHAFT COUPLING
2 – CONTACT PLATE
3 – COMMUTATOR PLATE
4 – BOTTOM CAP
5 – SILVER–CARBON BRUSH
6 – COUNTER BALANCE
7 – LIGHTWEIGHT PLASTIC TAIL



LIGHTWEIGHT VANE WITH 8–SEGMENT SWITCH (WM MODEL NO. W104–8C)

FIGURE 6




## ITEM DESCRIPTION

1 – GUY WIRES

2 – 15 FT. TOWER

3 – TURN BUCKLES

4 – W103 CONTACT ANEMOMETER

5 – W104 8C LIGHT WEIGHT SWITCH

6 – W1034 CROSS ARM ASSEMBLY

FIGURE 7

D5GWD

```
10 REM LINE NO. I5 DAY & HOUR      1ST COLUMN IS MINUTE OF READING
20 REM 2ND COLUMN IS 5ERV. TEMP.   3RD COLUMN I5 5ERV. D.P.
30 REM 4TH COLUMN IS SERV. WIND DIR.  5TH COLUMN IS SERV. WIND SPEED
40 REM 6TH COLUMN IS STATION TEMP.  7TH COLUMN IS STATION WIND DIR.
50 REM 8TH COLUMN IS 5TATION % R.H.  9TH COLUMN I5 5TATION WIND SPEED
0511 55, 54, 25, 12, 08, 54, 4, 32, 12
0512 55, 57, 27, 15, 05, 55, 4, 33, 10
0513 55, 58, 29, 12, 05, 58, 4, 33, 05
0514 5U, 60, 29, 15, 05, 60, 4, 33, 05
0515 55, 61, 30, 23, 05, 61, 4, 32, 03
0516 55, 61, 31, 28, 08, 62, 7, 32, 02
0517 55, 55, 30, 01, 08, 61, 8, 33, 06
0518 55, 52, 30, 04, 07, 56, 1, 37, 08
0519 55, 48, 31, 26, 03, 53, 1, 40, 05
0520 55, 41, 31, 30, 07, 49, 7, 47, 02
0521 55, 37, 29, 00, 00, 43, 8, 57, 05
0522 55, 38, 30, 31, 03, 40, 3, 62, 02
0523 55, 37, 30, 00, 00, 37, 8, 65, 00
600 53, 33, 27, 00, 00, 37, 2, 66, 00
0601 54, 31, 28, 11, 05, 34, 4, 68, 00
0602 55, 32, 29, 00, 00, 32, 4, 71, 02
0603 54, 28, 26, 00, 00, 31, 4, 72, 00
0604 54, 28, 26, 00, 00, 29, 4, 72, 00
0605 55, 28, 27, 00, 00, 28, 7, 74, 00
0606 55, 25, 25, 10, 02, 28, 7, 74, 00
0607 55, 30, 29, 00, 00, 26, 8, 75, 00
0608 55, 35, 31, 17, 04, 29, 6, 74, 00
0609 58, 38, 32, 11, 04, 35, 6, 67, 00
0610 55, 44, 32, 19, 03, 40, 5, 59, 02
0611 52, 46, 34, 00, 00, 45, 6, 54, 01
0612 55, 52, 33, 18, 04, 49, 7, 48, 02
0613 53, 53, 32, 08, 05, 53, 6, 44, 00
0614 54, 58, 33, 31, 04, 56, 3, 38, 01
0615 55, 59, 33, 30, 06, 60, 7, 35, 00
0616 55, 60, 33, 36, 12, 61, 8, 35, 03
0617 55, 58, 30, 01, 10, 60, 1, 34, 10
0618 55, 53, 30, 34, 07, 57, 2, 33, 10
0619 55, 48, 32, 35, 05, 54, 2, 38, 06
0620 55, 46, 34, 00, 00, 50, 2, 45, 02
0621 55, 43, 33, 00, 00, 47, 7, 52, 02
0622 55, 40, 32, 36, 04, 44, 2, 58, 02
0623 55, 39, 31, 14, 03, 41, 2, 61, 02
0700 55, 37, 33, 00, 00, 40, 5, 63, 02
0701 55, 33, 31, 13, 03, 38, 5, 67, 00
0702 55, 37, 32, 00, 00, 35, 5, 70, 01
0703 55, 31, 28, 33, 04, 36, 5, 69, 00
0704 55, 29, 28, 13, 03, 33, 1, 71, 00
0705 55, 29, 28, 00, 00, 30, 4, 73, 01
0706 54, 28, 27, 00, 00, 29, 3, 74, 00
0707 57, 31, 30, 24, 03, 28, 2, 74, 00
0708 56, 34, 34, 12, 04, 32, 7, 73, 01
0709 54, 39, 35, 18, 03, 37, 4, 68, 03
0710 55, 48, 35, 00, 00, 43, 5, 58, 01
0711 55, 49, 35, 09, 05, 49, 1, 53, 01
0712 53, 52, 35, 00, 00, 52, 8, 47, 00
0713 55, 56, 36, 25, 03, 57, 6, 43, 00
0714 55, 60, 36, 23, 03, 60, 7, 39, 00
0715 55, 62, 38, 29, 03, 65, 7, 35, 00
0716 55, 62, 39, 28, 04, 66, 8, 35, 00
0717 55, 59, 40, 00, 00, 66, 7, 37, 00
0718 56, 51, 39, 11, 04, 62, 8, 42, 00
0719 55, 47, 38, 29, 04, 54, 4, 51, 00
0720 55, 47, 38, 12, 04, 50, 6, 57, 02
0721 55, 43, 36, 00, 00, 49, 8, 58, 01
0722 55, 44, 38, 00, 00, 47, 1, 63, 00
0723 55, 43, 37, 00, 00, 44, 4, 67, 00
0800 55, 38, 35, 00, 00, 43, 1, 67, 00
0801 55, 36, 35, 09, 04, 40, 3, 71, 00
0802 55, 34, 33, 26, 03, 37, 4, 73, 02
0803 55, 35, 34, 10, 03, 36, 8, 72, 02
0804 55, 33, 33, 27, 04, 35, 6, 74, 02
0805 55, 33, 33, 00, 00, 34, 8, 74, 02
0806 55, 33, 33, 00, 00, 33, 8, 75, 00
0807 55, 35, 35, 00, 00, 33, 8, 75, 00
0808 55, 36, 36, 12, 04, 35, 4, 74, 00
0809 55, 43, 39, 00, 00, 41, 5, 68, 02
0810 55, 50, 39, 00, 00, 46, 6, 60, 00
0811 55, 56, 40, 21, 05, 51, 5, 53, 00
0812 55, 60, 40, 23, 04, 57, 8, 47, 01
0813 55, 63, 40, 26, 04, 60, 6, 42, 01
0814 53, 65, 42, 17, 03, 64, 7, 38, 00
0815 56, 67, 42, 00, 00, 66, 5, 38, 00
0816 54, 65, 43, 00, 00, 69, 6, 35, 00
0817 54, 58, 43, 10, 04, 66, 6, 39, 00
0818 56, 54, 42, 00, 00, 60, 6, 48, 00
0819 55, 49, 41, 00, 00, 55, 1, 54, 00
0820 55, 48, 42, 14, 03, 52, 7, 58, 00
0821 56, 50, 44, 00, 00, 49, 5, 63, 03
0822 55, 47, 43, 07, 04, 48, 5, 67, 00
0823 55, 46, 41, 05, 03, 47, 3, 65, 02
0900 55, 45, 40, 00, 00, 46, 3, 67, 02
0901 55, 43, 40, 00, 00, 44, 7, 69, 00
0902 55, 41, 38, 16, 03, 43, 8, 70, 01
0903 55, 40, 39, 31, 03, 42, 6, 70, 02
0904 55, 40, 37, 28, 04, 41, 7, 72, 00
0905 55, 39, 38, 12, 03, 41, 8, 72, 02
0906 53, 39, 37, 31, 03, 39, 7, 74, 01
0907 53, 42, 40, 00, 00, 39, 8, 73, 03
0908 55, 45, 41, 27, 05, 41, 3, 72, 00
0909 55, 48, 42, 19, 03, 45, 7, 66, 02
0910 55, 52, 42, 15, 04, 47, 6, 63, 02
0911 55, 56, 42, 06, 03, 51, 6, 58, 02
0912 52, 59, 42, 22, 13, 55, 3, 53, 01
0913 55, 61, 40, 20, 10, 60, 6, 43, 09
0914 55, 62, 40, 23, 15, 61, 6, 41, 08
0915 55, 60, 40, 23, 10, 63, 6, 40, 10
0916 55, 56, 46, 13, 08, 60, 6, 43, 08
0917 55, 53, 47, 05, 06, 56, 2, 55, 05
0918 54, 50, 49, 00, 00, 53, 1, 68, 05
0919 55, 47, 47, 06, 04, 51, 5, 70, 01
0920 55, 49, 47, 24, 05, 49, 6, 72, 01
0921 54, 48, 47, 36, 03, 49, 7, 71, 02
0922 55, 48, 48, 00, 00, 49, 2, 72, 01
0923 55, 46, 46, 30, 06, 48, 1, 73, 00
1000 55, 48, 48, 32, 03, 46, 8, 74, 06
1001 55, 45, 45, 02, 03, 47, 8, 73, 02
1002 55, 45, 45, 00, 00, 46, 8, 73, 00
1003 55, 45, 45, 00, 00, 46, 8, 73, 00
1004 55, 45, 45, 29, 04, 45, 8, 73, 00
1005 55, 45, 45, 00, 00, 45, 8, 73, 00
1006 55, 45, 45, 00, 00, 45, 8, 73, 00
1007 54, 46, 46, 12, 03, 45, 8, 73, 00
1008 57, 47, 47, 13, 04, 45, 6, 73, 02
1009 53, 48, 48, 15, 06, 47, 4, 73, 04
1010 56, 50, 50, 11, 05, 48, 5, 72, 04
1011 55, 53, 49, 12, 10, 49, 4, 70, 08
1012 52, 52, 50, 06, 06, 51, 4, 64, 06
1013 56, 55, 45, 04, 06, 50, 3, 69, 04
1014 55, 56, 44, 12, 03, 53, 1, 58, 03
1015 55, 56, 45, 13, 08, 53, 3, 58, 01
1016 55, 48, 41, 12, 13, 52, 4, 62, 07
1017 55, 47, 39, 12, 10, 46, 4, 64, 10
1018 55, 44, 38, 01, 11, 45, 4, 64, 08
1019 55, 47, 38, 15, 04, 43, 2, 67, 09
1020 55, 44, 37, 33, 05, 44, 1, 67, 04
1021 56, 44, 36, 12, 13, 43, 1, 66, 05
1022 55, 43, 36, 12, 10, 43, 4, 63, 10
1023 55, 42, 36, 12, 10, 41, 4, 68, 09
1100 55, 41, 34, 14, 09, 40, 2, 69, 07
1101 55, 40, 34, 13, 13, 39, 4, 65, 06
1102 55, 39, 32, 13, 07, 39, 4, 65, 10
1103 55, 40, 32, 09, 10, 38, 4, 65, 06
1104 55, 40, 32, 09, 12, 39, 4, 65, 06
1105 55, 37, 32, 13, 06, 38, 4, 64, 09
1106 55, 37, 30, 08, 06, 35, 4, 70, 02
1107 55, 41, 34, 11, 06, 34, 3, 68, 00
1108 55, 41, 33, 11, 04, 38, 4, 66, 00
1109 55, 42, 34, 20, 04, 39, 5, 64, 00
1110 55, 44, 34, 36, 04, 40, 6, 62, 00
1111 55, 45, 35, 18, 04, 42, 3, 60, 00
1112 55, 48, 36, 25, 06, 43, 7, 60, 00
1113 55, 48, 36, 36, 15, 45, 7, 59, 00
1114 55, 47, 35, 35, 17, 45, 1, 59, 00
1115 55, 47, 35, 36, 18, 44, 1, 59, 00
1116 55, 42, 34, 01, 15, 42, 1, 60, 00
1117 55, 40, 33, 36, 13, 39, 1, 64, 00
1118 55, 43, 35, 08, 04, 38, 1, 70, 00
1119 55, 42, 35, 00, 00, 39, 3, 71, 00
1120 55, 42, 35, 00, 00, 38, 4, 72, 00
1121 55, 42, 35, 12, 04, 38, 6, 72, 00
1122 55, 41, 35, 13, 04, 38, 4, 73, 00
1123 55, 41, 35, 10, 03, 37, 5, 74, 00
1200 55, 41, 35, 29, 03, 38, 4, 69, 00
1201 55, 41, 35, 31, 05, 38, 3, 69, 00
1202 55, 41, 35, 35, 05, 38, 8, 70, 00
1203 55, 40, 36, 31, 06, 38, 1, 71, 00
1204 55, 40, 36, 29, 03, 37, 8, 73, 00
1205 55, 40, 36, 02, 03, 37, 8, 74, 00
1206 55, 41, 38, 29, 04, 38, 1, 74, 00
1207 55, 41, 38, 00, 00, 38, 8, 74, 00
1208 55, 41, 38, 31, 04, 38, 8, 74, 00
1209 55, 42, 39, 29, 03, 39, 8, 73, 00
1210 55, 43, 39, 31, 05, 39, 8, 73, 00
1211 55, 44, 40, 31, 06, 40, 8, 70, 00
1212 55, 46, 41, 30, 07, 42, 8, 68, 00
1213 55, 48, 40, 31, 10, 44, 8, 64, 00
1214 54, 47, 38, 36, 11, 44, 1, 63, 00
1215 55, 46, 38, 36, 10, 43, 1, 63, 00
1216 55, 45, 37, 36, 07, 42, 1, 64, 00
1217 55, 45, 38, 31, 05, 42, 8, 65, 00
1218 55, 43, 36, 02, 09, 41, 1, 65, 00
1219 55, 43, 37, 25, 08, 41, 1, 67, 00
1220 55, 43, 37, 30, 06, 40, 8, 68, 00
1221 55, 43, 38, 00, 00, 40, 1, 68, 00
1222 54, 43, 38, 10, 03, 40, 8, 69, 00
1223 55, 43, 37, 33, 03, 40, 2, 69, 00
1300 55, 42, 35, 01, 06, 39, 2, 68, 00
1301 55, 42, 36, 28, 05, 39, 8, 69, 00
1302 52, 41, 36, 26, 05, 39, 7, 70, 00
1303 54, 41, 36, 31, 04, 38, 8, 72, 00
1304 52, 41, 38, 29, 05, 38, 8, 73, 00
1305 53, 40, 37, 32, 04, 38, 8, 73, 00
1306 55, 41, 38, 29, 04, 38, 8, 71, 00
1307 55, 42, 38, 08, 04, 39, 3, 70, 00
1308 55, 42, 38, 22, 03, 40, 7, 68, 00
1309 55, 45, 37, 36, 06, 41, 1, 63, 00
1310 55, 44, 36, 36, 10, 40, 2, 65, 00
1311 55, 44, 37, 36, 14, 40, 1, 65, 00
1312 55, 44, 38, 34, 06, 41, 1, 66, 00
1313 57, 42, 37, 28, 13, 40, 2, 70, 00
```

```
10 PRINT "CONFIDENCE LEVELS FOR TEMPERATURE MEASUREMENTS"
20 PRINT
30 PRINT
100 FILES DSGWD
110 REMARK 1 IS WEATHER SERVICE DATA  2 IS WEATHER STATION DATA
140 LET X1=0
150 LET X2=0
160 LET Y1=0
170 LET Y2=0
180 LET N=0
190 LET Z=0
200 READ #1: M,T1,P,D1,S1,T2,D2,H,S2
210 LET X=T2
220 LET Y=T1
230 REMARK X1=SUM X  X2=SUM X^2 Y1=SUM Y  Y2=SUM Y^2  Z=SUM X*Y
240 LET N=N+1
250 LET X1=X1+X
260 LET X2=X2+X^2
270 LET Y1=Y1+Y
280 LET Y2=Y2+Y^2
290 LET Z=Z+X*Y
300 IF END #1: THEN 320
310 GO TO 200
320 LET M=(N*Z-X1*Y1)/(N*X2-X1^2)
330 LET B=(Y1*X2-Z*X1)/(N*X2-X1^2)
340 LET S1=1/(N*(N-1))*(N*X2-X1^2)
350 LET S2=SQR(1/(N-2)*(Y2-B*Y1-M*Z))
360 PRINT "M=";M;"      B=";B;"      N=";N
370 PRINT
380 PRINT "VARIANCE =";S1
390 RESTORE #1
400 LET L=0
410 LET U=100
420 LET S=10
430 LET A1=50
440 LET T=.674
450 GO TO 540
460 LET A1=90
470 LET T=1.645
480 GO TO 540
490 LET A1=95
500 LET T=1.960
510 GO TO 540
520 LET A1 =99
530 LET T=2.576
540 PRINT
550 PRINT
590 PRINT
600 PRINT
610 PRINT " STATION";TAB(13);"ACTUAL";TAB(24);"FOR";A1;"% CONFIDENCE LEV
620 PRINT " READING";TAB(13);"VALUE";TAB(25);"ERROR IS PLUS OR MINUS"
630 PRINT
640 SETDIGITS 3
650 FOR I=L TO U STEP S
660 LET Y=M*I+B
670 LET C=T*S2*SQR(1+1/N+(I-(X1/N))^2/((N-1)*S1))
680 PRINT TAB(2);I; TAB(14);
690 PRINT Y;TAB(26);C
700 NEXT I
710 IF A1=50 THEN 460
720 IF A1=90 THEN 490
730 IF A1=95 THEN 520
740 PRINT
750 STOP
760 END
```

```
DSGCO1    12:57   ATL WED    06/20/73

CONFIDENCE LEVELS FOR TEMPERATURE MEASUREMENTS


M= .864215       B= 6.44058        N= 195

VARIANCE = 82.1233
```

| STATION READING | ACTUAL VALUE | FOR 50 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 0 | 6.44 | 2.14 |
| 10 | 15.1 | 2.1 |
| 20 | 23.7 | 2.06 |
| 30 | 32.4 | 2.04 |
| 40 | 41. | 2.02 |
| 50 | 49.7 | 2.02 |
| 60 | 58.3 | 2.04 |
| 70 | 66.9 | 2.06 |
| 80 | 75.6 | 2.1 |
| 90 | 84.2 | 2.15 |
| 100 | 92.9 | 2.21 |

| STATION READING | ACTUAL VALUE | FOR 90 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 0 | 6.44 | 5.23 |
| 10 | 15.1 | 5.12 |
| 20 | 23.7 | 5.03 |
| 30 | 32.4 | 4.97 |
| 40 | 41. | 4.94 |
| 50 | 49.7 | 4.94 |
| 60 | 58.3 | 4.97 |
| 70 | 66.9 | 5.03 |
| 80 | 75.6 | 5.12 |
| 90 | 84.2 | 5.24 |
| 100 | 92.9 | 5.38 |

| STATION READING | ACTUAL VALUE | FOR 95 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 0 | 6.44 | 6.24 |
| 10 | 15.1 | 6.1 |
| 20 | 23.7 | 5.99 |
| 30 | 32.4 | 5.92 |
| 40 | 41. | 5.88 |
| 50 | 49.7 | 5.88 |
| 60 | 58.3 | 5.92 |
| 70 | 66.9 | 6. |
| 80 | 75.6 | 6.1 |
| 90 | 84.2 | 6.24 |
| 100 | 92.9 | 6.42 |

| STATION READING | ACTUAL VALUE | FOR 99 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 0 | 6.44 | 8.2 |
| 10 | 15.1 | 8.01 |
| 20 | 23.7 | 7.87 |
| 30 | 32.4 | 7.78 |
| 40 | 41. | 7.73 |
| 50 | 49.7 | 7.73 |
| 60 | 58.3 | 7.78 |
| 70 | 66.9 | 7.88 |
| 80 | 75.6 | 8.02 |
| 90 | 84.2 | 8.21 |
| 100 | 92.9 | 8.43 |

```
RUNNING TIME:     8.3 SECS    I/O TIME :     1.3 SECS

READY
```

DSGCO2

```
100 PRINT "CONFIDENCE LEVELS FOR HUMIDITY MEASUREMENTS"
110 PRINT
120 PRINT
130 FILES DSGWD
140 REMARK 1 IS WEATHER SERVICE DATA  2 IS WEATHER STATION DATA
150 LET X1=0
160 LET X2=0
170 LET Y1=0
180 LET Y2=0
190 LET N=0
200 LET Z=0
210 READ #1: M, T1, P, D1, S1, T2, D2, H, S2
220 LET Z1=T1
230 IF Z1<32 THEN260
240 GO SUB 860
250 GO TO 270
260 GO SUB 960
270 LET P5=P1
280 LET Z1=P
290 IF Z1<32 THEN 320
300 GO SUB 860
310 GO TO 330
320 GO SUB 960
330 LET Y=P1/P5*100
340 LET X=H
350 REMARK X1=SUM X  X2=SUM X^2 Y1=SUM Y  Y2=SUM Y^2  Z=SUM X*Y
360 LET N=N+1
370 LET X1=X1+X
380 LET X2=X2+X^2
390 LET Y1=Y1+Y
400 LET Y2=Y2+Y^2
410 LET Z=Z+X*Y
420 IF END #1: THEN 440
430 GO TO 210
440 LET M=(N*Z-X1*Y1)/(N*X2-X1^2)
450 LET B=(Y1*X2-Z*X1)/(N*X2-X1^2)
460 LET S1=1/(N*(N-1))*(N*X2-X1^2)
470 LET S2=SQR(1/(N-2)*(Y2-B*Y1-M*Z))
480 PRINT "M=";M;"      B=";B;"      N=";N
490 PRINT
500 PRINT "VARIANCE =";S1
510 RESTORE #1
520 LET L=10
530 LET U=80
540 LET S=10
550 LET A1=50
560 LET T=.674
570 GO TO 660
580 LET A1=90
590 LET T=1.645
600 GO TO 660
610 LET A1=95
620 LET T=1.960
630 GO TO 660
640 LET A1 =99
650 LET T=2.576
660 PRINT
670 PRINT
680 PRINT
690 PRINT
700 PRINT " STATION";TAB(13);"ACTUAL";TAB(24);"FOR";A1;"% CONFIDENCE LEV
710 PRINT " READING";TAB(13);"VALUE";TAB(25);"ERROR IS PLUS OR MINUS"
720 PRINT
730 SETDIGITS 3
740 FOR I=L TO U STEP S
750 LET Y=M*I+B
760 LET C=T*S2*SQR(1+1/N+(I-(X1/N))^2/((N-1)*S1))
770 PRINT TAB(2);I; TAB(14);
780 PRINT Y;TAB(26);C
790 NEXT I
800 IF A1=50 THEN 580
810 IF A1=90 THEN 610
820 IF A1=95 THEN 640
830 PRINT
840 STOP
860  REM SATURATION VAPOR PRESSURE FOR WATER
870 LET B1=(5/9)*(Z1-32)+273.16
880  LET P1=-7.90298*(373.16/B1-1)+5.02808*.4343*LOG(373.16/B1)
890  LET P2=-9.3816E-7*(10^(11.344*(1-B1/373.16))-1)
900  LET P3=8.1328E-3*(10^(-3.49149*(373.16/B1-1))-1)
910  LET P4=.4343*LOG(1)
920  LET P0=P1+P2+P3
930 LET P1=10^P0
940 LET P1=29.921*P1
950  RETURN
960  REM SATURATION VAPOR PRESSURE FOR ICE
970 LET B1=(5/9)*(Z1-32)+273.16
980  LET P1=-9.09718*(273.16/B1-1)-3.56654*.4343*LOG(273.16/B1)
990 LET P2=.876793*(1-B1/273.16)+.4343*LOG(.0060273)
1000  LET P0=P1+P2
1010 LET P1=10^P0
1020 LET P1=29.921*P1
1030 RETURN
1040 END
```

DSGCO2    15:51  ATL WED   06/20/73

CONFIDENCE LEVELS FOR HUMIDITY MEASUREMENTS

M= 1.36799    B=-9.49044    N= 195

VARIANCE = 158.067

| STATION READING | ACTUAL VALUE | FOR 50 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 10 | 4.19 | 4.89 |
| 20 | 17.9 | 4.82 |
| 30 | 31.5 | 4.77 |
| 40 | 45.2 | 4.73 |
| 50 | 58.9 | 4.7 |
| 60 | 72.6 | 4.69 |
| 70 | 86.3 | 4.69 |
| 80 | 99.9 | 4.71 |

| STATION READING | ACTUAL VALUE | FOR 90 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 10 | 4.19 | 11.9 |
| 20 | 17.9 | 11.8 |
| 30 | 31.5 | 11.6 |
| 40 | 45.2 | 11.5 |
| 50 | 58.9 | 11.5 |
| 60 | 72.6 | 11.4 |
| 70 | 86.3 | 11.5 |
| 80 | 99.9 | 11.5 |

| STATION READING | ACTUAL VALUE | FOR 95 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 10 | 4.19 | 14.2 |
| 20 | 17.9 | 14. |
| 30 | 31.5 | 13.9 |
| 40 | 45.2 | 13.7 |
| 50 | 58.9 | 13.7 |
| 60 | 72.6 | 13.6 |
| 70 | 86.3 | 13.7 |
| 80 | 99.9 | 13.7 |

| STATION READING | ACTUAL VALUE | FOR 99 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 10 | 4.19 | 18.7 |
| 20 | 17.9 | 18.4 |
| 30 | 31.5 | 18.2 |
| 40 | 45.2 | 18.1 |
| 50 | 58.9 | 18. |
| 60 | 72.6 | 17.9 |
| 70 | 86.3 | 17.9 |
| 80 | 99.9 | 18. |

RUNNING TIME:   9.6 SECS   I/O TIME :   1.4 SECS

READY

DSGC03

```
10 PRINT "CONFIDENCE LEVELS FOR WIND SPEED MEASUREMENTS"
15 PRINT "WEATHER SERVICE MEASUREMENTS 3 KNOTS OR LARGER"
20 PRINT
30 PRINT
100 FILES DSGWD
110 REMARK 1 IS WEATHER SERVICE DATA  2 IS WEATHER STATION DATA
140 LET X1=0
150 LET X2=0
160 LET Y1=0
170 LET Y2=0
180 LET N=0
190 LET Z=0
200 READ #1: M,T1,P,D1,S1,T2,D2,H,S2
205 IF S1<3 THEN 300
210 LET X=S2
220 LET Y=S1*1.151
230 REMARK X1=SUM X  X2=SUM X^2 Y1=SUM Y  Y2=SUM Y^2  Z=SUM X*Y
240 LET N=N+1
250 LET X1=X1+X
260 LET X2=X2+X^2
270 LET Y1=Y1+Y
280 LET Y2=Y2+Y^2
290 LET Z=Z+X*Y
300 IF LNM>1105 THEN 320
310 GO TO 200
320 LET M=(N*Z-X1*Y1)/(N*X2-X1^2)
330 LET B=(Y1*X2-Z*X1)/(N*X2-X1^2)
340 LET S1=1/(N*(N-1))*(N*X2-X1^2)
350 LET S2=SQR(1/(N-2)*(Y2-B*Y1-M*Z))
360 PRINT "M=";M;"       B=";B;"       N=";N
370 PRINT
380 PRINT "VARIANCE =";S1
390 RESTORE #1
400 LET L=5
410 LET U=20
420 LET S=5
430 LET A1=50
440 LET T=.674
450 GO TO 540
460 LET A1=90
470 LET T=1.645
480 GO TO 540
490 LET A1=95
500 LET T=1.960
510 GO TO 540
520 LET A1 =99
530 LET T=2.576
540 PRINT
550 PRINT
590 PRINT
600 PRINT
610 PRINT " STATION";TAB(13);"ACTUAL";TAB(24);"FOR";A1;"% CONFIDENCE LEV
620 PRINT " READING";TAB(13);"VALUE";TAB(25);"ERROR IS PLUS OR MINUS"
630 PRINT
640 SETDIGITS 3
650 FOR I=L TO U STEP S
660 LET Y=M*I+B
670 LET C=T*S2*SQR(1+1/N+(I-(X1/N))^2/((N-1)*S1))
680 PRINT TAB(2);I; TAB(14);
690 PRINT Y;TAB(26);C
700 NEXT I
710 IF A1=50 THEN 460
720 IF A1=90 THEN 490
730 IF A1=95 THEN 520
740 PRINT
750 STOP
760 END
```

```
DSGC03     13:11   ATL  THUR   06/21/73

CONFIDENCE LEVELS FOR WIND SPEED MEASUREMENTS
WEATHER SERVICE MEASUREMENTS 3 KNOTS OR LARGER


M= .623889        B= 4.41076        N= 98

VARIANCE = 11.4753
```

| STATION READING | ACTUAL VALUE | FOR 50 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 5 | 7.53 | 1.36 |
| 10 | 10.6 | 1.89 |
| 15 | 13.8 | 1.97 |
| 20 | 16.9 | 2.08 |

| STATION READING | ACTUAL VALUE | FOR 90 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 5 | 7.53 | 4.54 |
| 10 | 10.6 | 4.62 |
| 15 | 13.8 | 4.8 |
| 20 | 16.9 | 5.06 |

| STATION READING | ACTUAL VALUE | FOR 95 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 5 | 7.53 | 5.41 |
| 10 | 10.6 | 5.51 |
| 15 | 13.8 | 5.72 |
| 20 | 16.9 | 6.03 |

| STATION READING | ACTUAL VALUE | FOR 99 % CONFIDENCE LEVEL ERROR IS PLUS OR MINUS |
|---|---|---|
| 5 | 7.53 | 7.11 |
| 10 | 10.6 | 7.24 |
| 15 | 13.8 | 7.52 |
| 20 | 16.9 | 7.93 |

```
RUNNING TIME:    5.4 SECS    I/O TIME :      .8 SECS

READY
```

DSGDIR

```
100 REM THIS PROGRAM PRINTS THE NUMBER OF TIMES THE WIND DIRECTION
110 REM  MEASUREMENTS DIFFER  (45 DEGREE INCREMENTS)
120 LET Z=1
130 DIM L(101)
140 DIM N(8)
150 LET S1=5
160 FOR I=1TO 8
170 LET N(I)=0
180 NEXT I
190 LET N=0
200 LET C=0
210 PRINT "FOR WEATHER SERVICE WIND VELOCITY >= ";S1;" KNOTS "
220 PRINT
230 PRINT
240 FOR I=1 TO 101
250 READ L(I)
260 NEXT I
270 FILES DSGWD
280 READ #1: M,T1,P,D1,V1,T2,D2,H,V2
290 FOR I=Z TO 101
300 IF LNM=L(I) THEN 330
310 NEXT I
320 GO TO 280
330 LET D1=INT ((D1*10+67.5)/45)
340 IF D1<9 THEN 360
350 LET D1=D1-8
360 LET Z=I
370 IF V1<S1 THEN 280
380 LET N=N+1
390 LET I=D2-D1+4
400 IF  I>8 THEN 430
410 IF I<=0 THEN 450
420 GO TO 460
430 LET I=I-8
440 GO TO 460
450 LET I=I+8
460 LET N(I)=N(I)+1
470 IF MORE #1:THEN 280
480 PRINT
490 PRINT
500 FOR I=1 TO 8
510 PRINT "N(";I-4;") =";N(I)
520 LET C=C+N(I)
530 NEXT I
540 PRINT
550 PRINT
560 PRINT "N =";N,"C =";C
570 PRINT
580 PRINT
590 DATA 511,512,518,601,606,608,609,610,616,617,618,619,623,700,701
600 DATA 703,704,707,708,719,802,804,808,813,817,820,822,823,903,904
610 DATA 905,906,908,909,910,914,915,920,923,1000,1004,1007,1009,1010
620 DATA 1011,1013,1016,1017,1018,1019,1021,1022,1023,1102,1104,1106
630 DATA 1107,1108,1113,1114,1115,1116,1117,1118,1122,1123,1200,1201
640 DATA 1203,1204,1205,1206,1208,1209,1210,1211,1212,1213,1214
650 DATA 1215,1216,1217,1218,1219,1220,1222,1223,1300,1301,1302,1303
660 DATA 1304,1305,1306,1307,1308,1309,1310,1311,1312,1313
670 END
```

```
DSGDIR     15:38  ATL  THUR  06/28/73

FOR WEATHER SERVICE WIND VELOCITY >=  5  KNOTS


N(-3 ) = 1
N(-2 ) = 1
N(-1 ) = 2
N( 0 ) = 32
N( 1 ) = 12
N( 2 ) = 2
N( 3 ) = 3
N( 4 ) = 1


N = 54          C = 54



RUNNING TIME:    9.7 SECS   I/O TIME :    1.5 SECS

READY
```

USFS EQUIPMENT DEVELOPMENT CENTER
missoula